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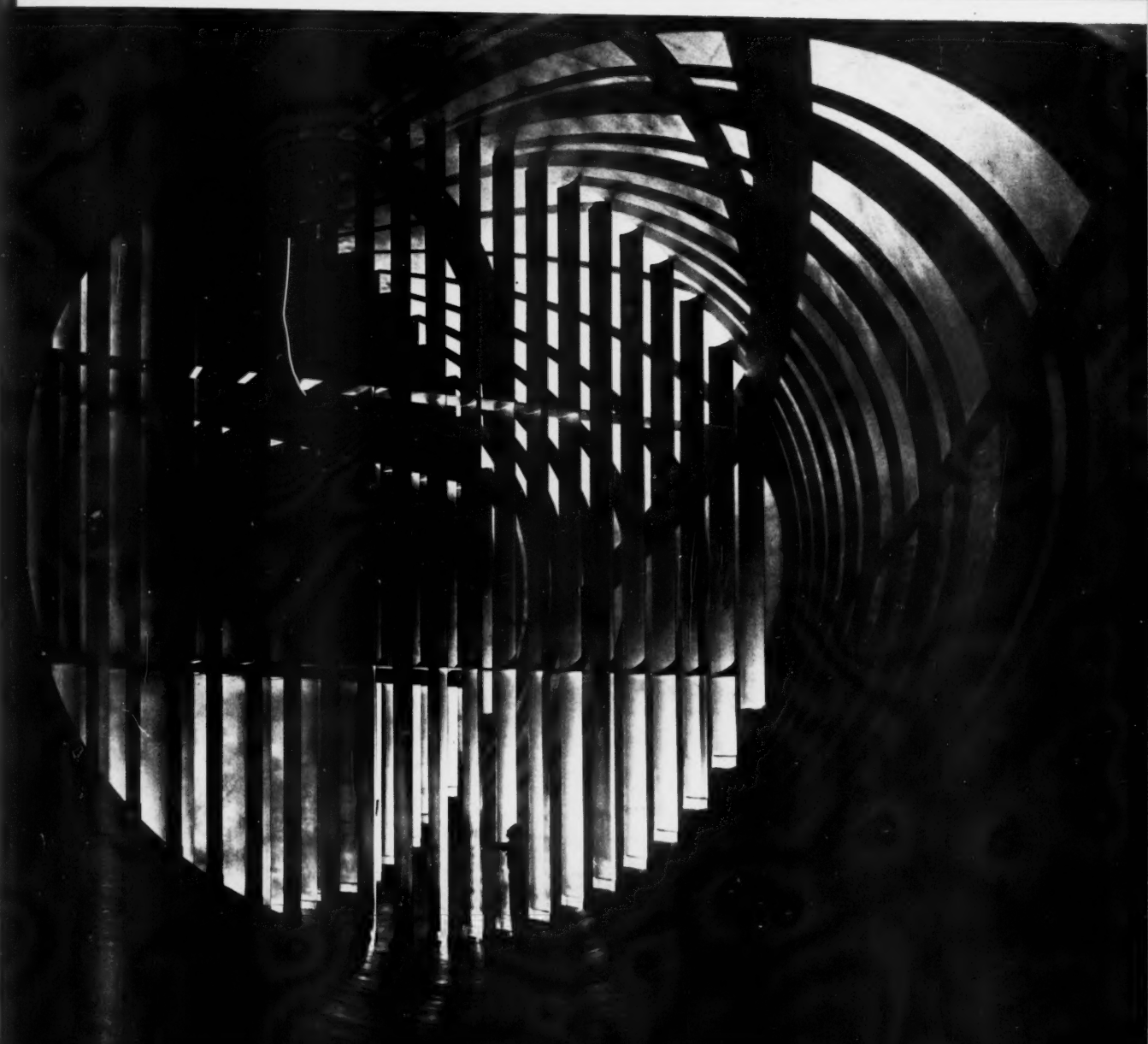
SEPTEMBER 1946



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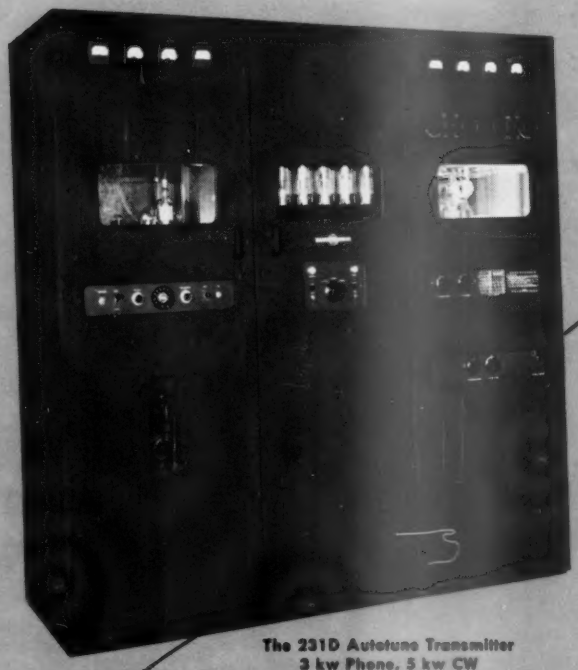

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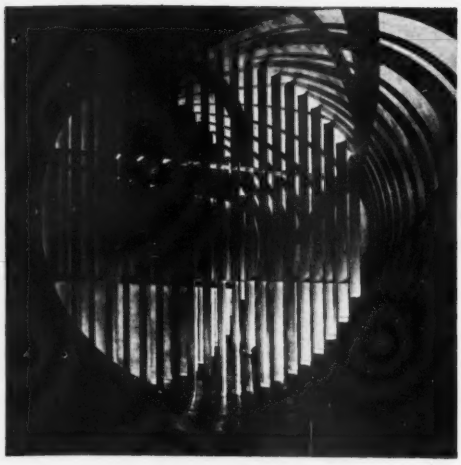

Cover—Turning vanes in the N.A.C.A. Mofett Field Transonic Wind Tunnel. (See page 73).

AERONAUTICAL ENGINEERING REVIEW

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I.A.S. News

A Record of People and Events of Interest to Institute Members

Annual I.A.S. Air Transport Meeting Scheduled for Washington, October 24

T. P. Wright Guest Speaker at Dinner Sponsored Jointly by Institute of the Aeronautical Sciences and Institute of Navigation.

FOR THE FOURTH TIME SINCE 1939, members and guests of the Institute will assemble to discuss those problems of air transportation that fall in the field of the aeronautical sciences. Matters concerning operating procedures, maintenance practices, and traffic promotion come within the purview of other associations, but there are many problems facing the air lines today which are of direct interest to the aeronautical engineer and properly come within the scope of I.A.S. activities.

By fortunate coincidence, the Institute of Navigation has scheduled its Annual Meeting in Washington on the same date. Because of a common interest in certain problems and because of a community of membership in both societies, the officers of the Institute of the Aeronautical Sciences and the Institute of Navigation have agreed on certain cooperative activities in Washington. The Thursday technical sessions of either society will be open to members of the other. The Friday, October 25, sessions of the I. of N., will deal primarily with air navigation problems.

The afternoon session, beginning at 2:30, will be a joint session with the Institute of Navigation and will be devoted to landing and navigational devices. Joseph Lyman, Research Engineer of the Sperry Gyroscope Company, Inc., will discuss "The Application of Microwaves to Instrument Landing of Airplanes." The Institute of Navigation will sponsor a paper by L. F. Jones of RCA on the latest developments in radar equipment.

The dinner, at 7:30 p.m. in the Congressional Room of the Statler, will also be a cooperative affair. The program includes the presentation (to a recipient as yet unnamed) by Sherman Fairchild, of the Col. Thomas Thurlow Navigation Award for the outstanding contribution to the science of navigation for the year 1945. Guest speaker for the evening will be Theodore P. Wright, Past-President and Honorary Fellow of the Institute of the Aeronautical Sciences, and at present U.S. Administrator of Civil Aeronautics.

Technical sessions of the I.A.S. will open at 9:30 a.m., Thursday, October 24, in the Federal Room of the Statler. The morning session will be under the chairmanship of Charles Froesch, Chief Engineer, Eastern Air Lines, Inc. Three papers are scheduled, the first, "Air Conditioning of Transport Aircraft for Year-Round Comfort," by Bruce Del Mar, of Douglas Aircraft Company, Inc., and the second, "A Survey of Aircraft Rescue Requirements," by Jerome Lederer, of Aero Insurance Underwriters. The third paper will be presented by members of the Provisional International Civil Aviation Organization. After the formal papers there will be a round-table discussion of air-transport aircraft requirements of the immediate future, with special reference to the value of higher speeds.

The I.A.S. Program Committee for the Air Transport Meeting is made up as follows: W. A. M. Burden, Charles Froesch, Otto E. Kirchner, John C. Leslie, J. Parker van Zandt, B. J. Vierling, and T. P. Wright. The arrangements with the Institute of Navigation were made through C. Towner French, of Fairchild Camera & Instrument Corporation.

T. P. Wright.

I.A.S. Calendar

October 24, 1946	Air Transport Meeting, Hotel Statler, Washington, D.C.
December 17, 1946	Tenth Wright Brothers Lecture, Washington, D.C.
January 28–30, 1947	Fifteenth Annual Meeting, New York, N.Y.

For further details see page 29.

Program Personalities

I.A.S. Annual Summer Meeting

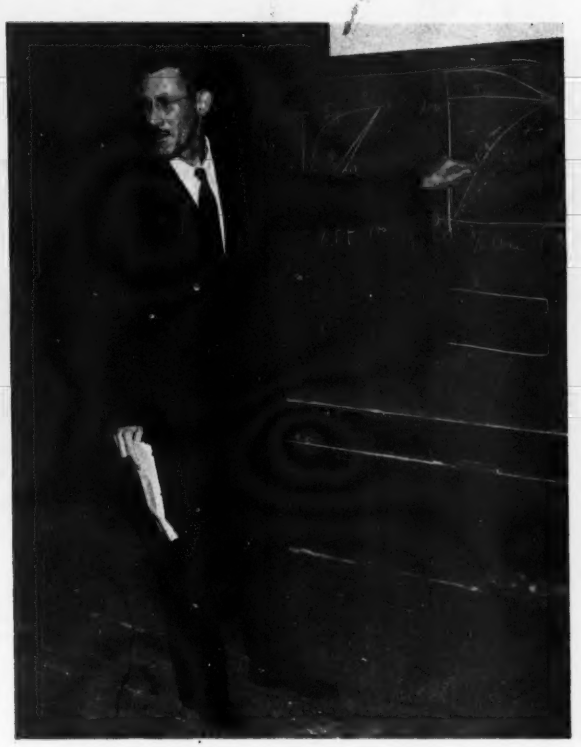
Los Angeles

Flashlights flickered through the sessions in Royce Hall as North American's photographic crew filmed I.A.S. program personalities for posterity. Sound effects were amplified and recorded for subsequent analysis by Douglas electronic experts. Herewith, a few "stills" of some of the participants who contributed greatly to the success of the meeting. *Above:* "Gene" Root, Program Committee Chairman, to whom must go much of the credit for a job well done.

Left: Aerodynamics Chairman, Clark B. Millikan, Acting Director of GALCIT, who steered a steady course through shock waves, boundary layers, and tail-load criteria.

Above: The Opener—John F. Parsons, Assistant Engineer-in-Charge, Ames Aeronautical Laboratory, N.A.C.A., who served as Chairman for the first technical session on Flight Testing.

Below: "You see, it's this way . . ." says Norton B. Moore, then of Aerojet Engineering Corp., in explaining the whys and wherefores of a Variable Thrust Liquid Rocket Motor at the final session.



Below (and left, on opposite page): "Quiz Kids" at work. A highly successful experiment—the symposium on Fatigue in Aircraft Structures on July 19. Chief Quizzer (at desk)—Charles R. Strang, Chief, Structures and Weights Section, Douglas, Santa Monica; the "Kids"—*left to center*—R. L. Schleicher of North American, R. V. Rhode of N.A.C.A., and George Snyder of Boeing Aircraft; *right to center*, J. F. McBrearty of Lockheed, L. R. Jackson of Battelle Institute, and M. A. Minor of Douglas Aircraft (and the unseen audience, which took a generous part).

Above: I.A.S. President, Arthur E. Raymond of Douglas, introduces speaker-of-the-evening, General of the Army, H. H. Arnold. On the left is Past-President R. H. Fleet. On the page opposite appear excerpts from General Arnold's speech. It was broadcast over the Columbia West Coast network. Some 500 I.A.S. members and guests were in attendance.

Below: Col. H. M. McCoy, Chief of Air Documents Division of Intelligence (T-2), Air Matériel Command, Wright Field, explains how hundreds of tons of technical documents were taken away from Germany's aircraft industry and have been made available to U.S. engineers. Aircraft Design Chairman Edward Schmued of North American backs up the Colonel.

Above: William Bollay, formerly of Harvard University, latterly of the Bureau of Aeronautics, Navy Department, and presently head of Technical Research for North American, piloted the discussion of Propulsion Methods on July 19.

Said the General .....

(Quotes from the Dinner Address)

"WE are again in danger—after having won a war—of throwing away the fruits of victory; of failing to make the necessary sacrifices for the establishment of a world in which all nations can feel secure . . . . . It will depend to a large degree upon all of us in the aeronautical sciences, whether the America we have built for our children will be the hope of the world, or the battleground of the next great conflict."

★ ★ ★ ★ ★

"THE future security of the United States lies in the air . . . . . If we allow ourselves to be complacent, our country will be vulnerable to attack and devastation as never before in its history. This is the considered opinion of everyone who has analyzed the experience of the last war and calculated the probable development of air power in the near future and its ability to carry atomic, biological and chemical warfare to every corner of the globe . . . . . Only by backing with military power our firm intention to prevent aggression leading to another world war can we instill hope in other nations that the slow, but steady, progress of mankind toward a world of law-abiding people is continuing."

★ ★ ★ ★ ★

"THE development of atomic, biological, and chemical warfare has threatened the importance of our natural resources and industrial capacity as decisive factors in war. It can be safely assumed that the United States, which, by throwing its power into the scales, decided the last two struggles, will be the first to be attacked in the future . . . . . Of all the great nations, none is more vulnerable to surprise attacks than we are . . . . . The best defense will be to convince other countries that the United States is fully prepared to retaliate immediately with far greater destructive force against any aggressor; that we will answer any unprovoked attack by wholesale devastation. Physicists, chemists and other scientists must preserve American leadership in their fields, but particularly you in the aeronautical sciences carry the responsibility to develop the strategic means of delivery—whether the load be a warhead, a bomb, or biological or chemical weapon; cargo or men; whether the vehicle be piloted or pilotless; whether it traverse the air envelope alone, or course through space beyond the atmosphere. New weapons will be useless unless delivered to the required spot at the right moment."

★ ★ ★ ★ ★

"THE Air Forces and the aeronautical scientists and technologists will have to continue to improve the cooperation which developed between them during the war . . . . . By the integration in the war effort of the cumulative resources of the natural and social sciences, and of the talents and experience furnished by economists, scientists, technicians, management and labor, the armed forces were enabled to have at their disposal many new techniques and weapons with which to outwit and overwhelm the enemy . . . . . It will be an enduring source of satisfaction to me to reflect on the progress we have made, both military and civilian, in this field of integration. Through the use of select civilians, we in the Air Forces were able many times to avail ourselves of the vital resources they commanded, whether these resources lay primarily in the intellect of the individual or in the organization with which he was associated."

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"THROUGH mixing scientific and operational talent we were able to develop the application of devices for blind bombing and the control of tactical air which otherwise would never have reached the combat theater . . . . . There came from this cooperative procedure a mutual understanding which, I am convinced, stimulated the imagination of the scientists, and inspired them to new and greater creative achievements. It is your duty, and that of the Air Forces, to make sure that the pattern of integration created by the war is translated into a peacetime counterpart, which will not only familiarize the military with the advances made in science and industry, but will attract into our planning for national security all the civilian resources which can contribute directly and indirectly to the defense of the nation."

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(A Limited Number of Copies of the Full Text of General Arnold's Address Are Available to I.A.S. Members on Request)

By-Laws and Membership Requirements Revised

During the past year the Membership Committee of the Institute has been studying the requirements for membership with the object of making them conform more closely to the present methods of classifying scientists and engineers within the aeronautical profession and industry. At a meeting of the Council in Los Angeles on July 17 the Council approved the changes recommended by the Committee.

Some changes were made in the By-Laws to provide for the new office of Director but the major changes pertain to membership qualifications. These have been made more definite and experience and education have been emphasized. The major changes are briefly as follows:

Industrial and Affiliate Grades.—These grades have been discontinued and the grade of Associate Member added. Members presently classified as Industrial will automatically become Associate Members but may apply for advance to a higher grade of membership. Affiliates will be notified by letter of the discontinuance of this grade and will be given the opportunity to file an application for transfer to another grade.

Technical Members.—Technical Members who will be 26 years of age or older as of each October 1 will be charged MEMBER grade dues, as is recognized practice in other professional societies. The present Technical Members who will be 26 years or older on October 1, 1946, will be notified by letter of this change and given the opportunity to apply for an advance in grade of membership.

Dues and Entrance Fee.—No changes have been made in dues except for the Technical Members 26 years of age or older. Members residing in Canada will be charged the same dues as members in the United States. Members residing outside the United States or Canada will be charged annual dues of $10.00. The entrance fee for new members has been increased from $5.00 to $10.00, but there will be no entrance fee for Student Members applying for transfer to the Technical Member grade or for applicants permanently residing outside the United States and Canada.

The new membership requirements were placed in effect August 1 for new applicants for membership and will go into effect for present members beginning with the new fiscal year, October 1, 1946. The revised By-Laws regarding membership are printed in full on the following page for the information of all members of the Institute.

I.A.S. Membership Requirements

Article I—Membership

SECTION 1. All persons engaged in the practice of the aeronautical sciences or in other work which contributes to the advancement of the aeronautical sciences shall be eligible in one of the grades of membership of the Institute. Consideration in grading is given to professional education and experience, publications, academic position, membership in other scientific and engineering societies, record of aeronautical designs created and contributions to scientific knowledge. A Bachelor's Degree in science or engineering shall be considered the equivalent of four years of aeronautical experience. All applicants must sign, before admission, an agreement that they will conform to the Constitution, By-Laws, and Rules of the Institute.

SECTION 2. Honorary Fellows shall be persons of eminence in aeronautics and shall be elected by the Fellows (including Honorary Fellows) of the Institute residing in the United States. Not more than one person residing in the United States, nor more than one person residing in a foreign country, may be elected as Honorary Fellow in any one year.

SECTION 3. Honorary Members of the Institute may be elected by the Council for a period of one year.

SECTION 4. Benefactors shall be persons who have contributed to the Institute not less than one thousand dollars.

SECTION 5. A Fellow shall have been an Associate Fellow for one year or more and have attained a position of distinction in aeronautics. He shall have made notable and valuable contributions in one of the aeronautical sciences or in aeronautical engineering. Not more than ten Fellows residing in the United States and ten Fellows residing in foreign countries may be elected each year by vote of the Honorary Fellows and Fellows by secret mail ballot under rules prescribed by the Council. Fellows shall be proposed and elected by the Honorary Fellows and Fellows of the Institute residing in the United States. A favorable vote of three-fourths of those voting shall be required for election.

SECTION 6. An Associate Fellow shall have been engaged for not less than ten years in the practice of the aeronautical sciences; and shall have been in responsible charge of important scientific or engineering work in aeronautics, or shall have done original work of outstanding character, or shall have otherwise made outstanding contributions to the aeronautical sciences. Applicants for this grade shall be recommended by not less than four members of the Institute of whom two or more shall be Fellows or Associate Fellows.

SECTION 7. MEMBERS shall be persons who have been engaged in professional work for at least eight years and have acquired a recognized standing in engineering, design, research, instruction, test flying, the application of the aeronautical sciences, or the technical development of the manufacture or operation of aircraft, aircraft power plants or other essential components or accessories of aircraft. To qualify for this grade applicants shall be recommended by not less than four persons of whom not less than two shall be members of the Institute.

SECTION 8. Associate Members shall be persons engaged in the application or development of aeronautics in administrative or other positions and who have acquired a recognized standing in aeronautics. Applicants for this grade shall be recommended by not less than four persons of whom not less than two shall be members of the Institute.

SECTION 9. Technical Members shall be former Student Members who have graduated and others engaged in scientific or engineering work in aeronautics or fields closely related to aeronautics. To qualify for this grade applicants shall be recommended by not less than four persons of whom not less than one shall be a member of the Institute.

SECTION 10. Student Members shall be undergraduate or graduate students attending those universities or schools where branches of the Institute have been organized. Student Members shall comply with, and be subject to, the Rules for Student Membership adopted by the Council. Student Members, provided they qualify, will be transferred to the grade of Technical Membership on the 30th day of September following the date of their graduation.

SECTION 11. Corporate Members shall be manufacturers of aircraft, power plants, components, equipment and supplies; operators of aircraft or those who provide services to the aircraft or air transport industries.

SECTION 12. The Secretary shall forward to the Membership Committee all applications for membership or for regrading. The Secretary shall notify applicants of the decisions of the Membership Committee.

SECTION 13. Honorary Fellows, Fellows, Honorary Members, Associate Fellows, MEMBERS and Associate Members shall be entitled to vote at meetings of the Institute, if in good standing. Proxies authorizing a voting member to vote for an absent member shall be signed by such absent member and shall be submitted to the Secretary in advance of the meeting for verification of the member's right to vote.

Article II—Dues

SECTION 1. An entrance fee of Ten Dollars shall be payable on election to the grades of Technical Member, Associate Member, MEMBER or Associate Fellow, except that no entrance fee shall be payable by an applicant residing permanently outside the United States and Canada or by a Student Member applying, within the prescribed time limit, for admission as a Technical Member.

SECTION 2. The annual dues shall be:

Honorary Fellows	None
Honorary Members	None
Benefactors	None
Fellows	$16.50
Associate Fellows	12.50
MEMBERS	10.50
Associate Members	10.50
Technical Members over age 26	10.50
Technical Members under age 26	6.50
Student Members	None
Corporate Members	Set by Council

Dues shall include a subscription to the Aeronautical Engineering Review. Student Members may subscribe for the Review at one-half the regular subscription rate. All members of the Institute residing in the United States and Canada may subscribe for the Journal of the Aeronautical Sciences at one-half the regular subscription rate.

For members residing permanently outside the United States and Canada annual dues shall be $10.00 in all grades and shall include subscription to the Aeronautical Engineering Review and the Journal of the Aeronautical Sciences.

Beginning on the first of October next following his 26th birthday dues of a Technical Member shall be the same as those of a MEMBER.

SECTION 3. Dues shall be payable annually in advance on October 1st.

SECTION 4. The Council may waive the payment of dues by any member. Members whose dues have been waived, or who are in arrears, may not subscribe to the Institute publications at members' special reduced rates.

SECTION 5. Members shall not be entitled to any return of fees or dues upon severance of their connection with the Institute.

SECTION 6. Every person admitted to membership in the Institute shall be considered liable for payment of dues until his membership shall have terminated by written resignation or otherwise. Resignations may be submitted by any member during the fiscal year in which his dues have been paid. Resignations submitted after such period may not be accepted until all dues have been paid.

Von Kármán Receives Medal for Merit

Dr. Th. von Kármán, Director of the Guggenheim Aeronautics Laboratory at the California Institute of Technology and an Honorary Fellow of the Institute, has been awarded the Medal for Merit by the War Department in recognition of his work during the war. The medal is the highest decoration awarded to a civilian.

Dr. von Kármán was Chairman of the Scientific Advisory Group during the war and heads the new Army Air Forces Scientific Advisory Board. Many of the wind tunnels of the A.A.F. were constructed under his guidance and advice, and his analysis in supersonic aerodynamics indicated the range over which supersonic aircraft would be capable of operating.

Gifts to the Aeronautical Archives

Harry F. Guggenheim added 45 early aeronautical books to his previous generous gifts. The earliest of these was Hermann Flayder's *De Arte Volandi*, Tübingen, 1627, and the latest was *Cenno sull'Aerostato dell'Aeronauta Antonio Cornaschi*, Naples, 1843. Twenty-nine of the books were published in Italy, including Borelli's *De Motu Animalium*, Rome, 1680–81, the Italian edition of Faujas de Saint Fond's *Descrizione delle Esperienze della Macchina Aerostatica dei Signori di Montgolfier*, Venice, 1784, and the three issues of the *Giornale Aerostatico*, January, February, and March, 1784, published in Milan.

Howard A. Scholle gave *All the World's Aircraft* for 1909-10, 1910-11, and 1923. Eric Hildesheim brought from Norway a biography of Gustav de Laval, 1845–1913, published in 1943.

Mrs. James Means added books, magazines, and clippings to the previous generous gifts of her late husband, Dr. James Means.

A menu of the Hotel Astor of 1909 showing a picture of a Zeppelin was given by Fred A. Muschenheim. J. D. M. Gray, of Orillia, Ontario, gave more than 40 slides made from photographs of aeronautical activity in Europe from 1909 to 1912. Charles Villiers gave a model of a projected six-engined transport airplane. Mrs. Bella C. Landauer and Dr. Alexander Klemin added books and pamphlets to their previous generous gifts.

Rear Adm. Luis de Florez, F.I.A.S., formally commissions the Daniel Guggenheim estate as the Navy Department's Special Devices Center. Admiral de Florez, deputy chief of the Office of Research and Inventions, is at the speakers' pulpit; seated at the right are: *(front row)*, former Assistant Secretary of the Navy H. Struve Hensel, Captain Donald L. Hibbard; *(rear row, left to right)*, Commodore H. A. Schade, Rear Admiral J. J. Ballantine, Rear Admiral S. M. Kraus; *(rear, standing)*, Commander N. A. Gaylor. Five hundred guests attended the commissioning of the base.

Documents relating to applications before the Civil Aeronautics Board regarding new air routes and extensions of existing routes were received from Braniff Airways, Inc., Eastern Air Lines, Inc., Pan American Airways, Inc., Southwest Airways, Inc., Transcontinental & Western Air, Inc., and United Air Lines, Inc.

Additional gifts were received from the Aircraft Industries Association, the French Embassy, William S. Friedman, Peter Masefield, and the U.S. Civil Aeronautics Administration, Coast Guard, War Department, and the Senate and House document rooms.

Corporate Member Expands

Curtiss-Wright Corporation has purchased outright the Victor Animatograph Corporation of Davenport, Iowa, manufacturers of 16-mm.-motion picture projectors, cameras, and allied equipment. The products of the Victor company, which was organized in 1910 to manufacture equipment and materials for the motion picture industry, have been used in schools and churches and for sales promotional work, as well as by the Army and Navy, for training purposes. There will be no change in the location, personnel, or operation of the newly acquired company.

Sections and Branches

Buffalo Section

On June 28 the first Annual Dinner Dance was held at the Buffalo Trap and Field Club, attended by 160 members and guests. Following the dinner, Chairman Benson Hamlin called a special meeting of the Section members to present a nomination slate of officers for the next fiscal year.

At a meeting held on July 8, Air Commodore Frank Whittle, R.A.F., repeated the lecture on gas turbines first given at the special meeting of the New York Section on June 27.

Cleveland Section

A dinner meeting held on July 12 was attended by 250 members and guests. Air Commodore Frank Whittle, R.A.F., gave at this meeting the lecture on aircraft gas turbines which was first given at the special meeting of the New York Section.

San Diego Section

On June 6 a dinner meeting was held at the San Diego Women's Club Building under joint sponsorship with

the Society of Automotive Engineers. The principal speakers were J. M. Gwinn, Jr., Chief Engineer, Personal Aircraft, Consolidated Vultee Aircraft Corporation, who spoke on the subject "The Application of Two-Dimensional Control Systems to Light Aircraft" and B. F. Raynes, Tooling Supervisor, Rohr Aircraft Corporation, who presented "Light Plane Design Criteria." Mr. Gwinn stressed the great need for simplified control of light aircraft if greater safety is to be achieved. He stated that the factor of skill is a requirement for safety in present control systems. Because the airplane, unlike the automobile, has six freedoms of motion, its major hazard is that it may move in a direction other than that in which it is pointed. This is true not only laterally but also in elevation, a condition that makes such procedures as landing difficult. Mr. Gwinn stated that if the attitude of the airplane could be kept level even in a glide and the throttle used as the altitude control, a great deal could be accomplished to eliminate landing accidents, both by reducing the skill and judgment required in landing and by eliminating nose-down contacts with the ground. The airplane should be designed structurally for this type of landing, and when so designed it will eliminate the necessity for depth perception.

Mr. Raynes' paper was devoted to the design features of the Rohr Aircraft Corporation light plane, the M.O.-1, which incorporates many design features that are somewhat unorthodox. The airplane is two-place, side by side, of all-metal construction, with cantilever wing surfaces and retractable tricycle landing gear. The design is a canard type with stabilizing surfaces forward of the wing, and incorporates a submerged engine installation under the wing and just aft of the passengers. The engine drives a blower and a pusher propeller at crankshaft speed. The blower draws in air from slots around the fuselage and forces this air across the engine and through the fuselage into the wings. The wings are air-tight and act as ducts to transmit the air under pressure to full-span slots located on the upper surfaces at 80 per cent of chord point. Air under pressure is likewise transmitted to the front surface, which has a full-span pressure slot in the upper surface. Engine exhaust is transmitted along with additional air under pressure to a pressure slot around the fuselage just forward of the propeller spinner. The variable-pitch propeller and blower are mounted on a common shaft and a clutch is provided between this shaft and the engine. In the event of power failure the propeller is used as a windmill and provides the power required to operate the blower.

Following Mr. Raynes' talk, the meeting was opened for discussion.

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Donald W. Finlay
Charles Froesch
Leroy R. Grumman
R. Paul Harrington
W. Wallace Kellett
Otto E. Kirchner
Jerome Lederer
Robert J. Minshall
Earl D. Osborn
Elmer A. Sperry, Jr.
Ernest G. Stout
Fred E. Weick

Pacific Coast Office
6715 Hollywood Blvd., Hollywood 28, Calif.

Aeronautical University

At a meeting held on July 10 the following officers were elected: Chairman, Leonard Miller; Vice-Chairman, George Egner; Secretary, James Nishimura; Treasurer, Max Gooch; Sergeant-at-Arms, William E. Stakee; and Faculty Adviser, J. Cummins. Thad Perry presided.

Alabama Polytechnic Institute

At a meeting held on June 27 the film *Cannon on Wings* was shown.

At the July 23 meeting Robert H. Harris gave a short talk on the P-80 which he flew as Test Pilot while in the A.A.F. The film *Report on Jet Propulsion* also was shown. Vice-Chairman Evan F. Slider, Jr., presided.

Carnegie Institute of Technology

At a meeting held on July 9 Philip H. Rose spoke on the subject "Features of the B-32." On July 23 Melvin H. Snyder, Jr., gave a talk on the "P-47 Induction System." At a meeting held on July 30, John W. Carlson spoke to the group on "C.A.A. Regulations Regarding Construction of Airports." Chairman Donald Cotton presided.

Georgia School of Technology

At a meeting held on June 6 the following officers were elected: Chairman, Lamar A. Ramos, Jr.; Vice-Chairman, Theodore Alvin Vogel; Secretary, Harlo Arthur Hunter; and Treasurer, Charles R. Pendleton. The Student Branch Lecture Award was won by Charles H. Green, Jr. The Student Branch Scholastic Award was presented to Donald E. Dufford.

University of Illinois

The Student Branch Scholastic Award was granted to Allen I. Ormsbee. At a meeting held on July 10,

Dr. Bryan, Director of the Illinois Institute of Aeronautics, gave a talk on the functions of his organization and its relationship to aeronautical engineering students.

Illinois Institute of Technology

Jacob Kramer is the recipient of the Student Branch Scholastic Award and Leo Thomas Feehery is the winner of the Student Branch Lecture Award at the Illinois Institute of Technology Student Branch.

Louisiana State University

Richard L. Merrell has won the Student Branch Scholastic Award at Louisiana State University. Eugene J. Verret will receive the Student Branch Lecture Award.

Spartan College of Aeronautical Engineering

Joel W. Alldredge has been selected to receive the Student Branch Scholastic Award.

News of Members

Lewis H. Abraham is now Chief Engineer of the Empire Engineering Company.

Malcolm J. Abzug has joined the El Segundo Division of Douglas Aircraft Company, Inc., as an Engineer.

Guy E. Adams is now a Flight Test Engineer at McDonnell Aircraft Corporation.

Richard E. Adams has joined the Langley Memorial Aeronautical Laboratory, N.A.C.A., as an Aeronautical Engineer.

Ernest Adler, Jr., is now Chief Engineer of All American Aircraft, Inc.

Rudolph C. Adler has formed his own company, R. C. Adler & Company.

Rudolph Anger has joined the Civil Aeronautics Administration as an Aircraft Factory Inspector.

Jay P. AuWerter is now President of Atlantic Automatic Company.

Egbert F. Au Yong has joined Culver Aircraft Corporation as a Junior Engineer.

George M. Baggs is now a Stress Analyst at United Helicopter Company.

Charles L. Baker has joined the Texas Engineering & Manufacturing Company, Inc., as Assistant Project Engineer.

Louis F. Becker, Jr., is now a Project Engineer at the Texas Engineering & Manufacturing Company, Inc.

Eugene J. Bedell has joined Aero Spark, Inc., as General Manager.

Norman R. Beers is now Associate Professor of Aerological Engineering at the Postgraduate School, U.S. Naval Academy.

Charles R. Beltz has joined the Chrysler Corporation as a Field Engineer.

Robert M. Berns is now a Partner in the firm of The Boat Builders.

Raymond L. Bisplinghoff has joined the Massachusetts Institute of Technology as an Assistant Professor of Aeronautical Engineering.

Sydney D. Black is now Head of the Airplane Dynamics Research Group, Engineering Research Department, at Curtiss-Wright Corporation (Columbus Plant).

Carl F. Blakely has joined Socony-Vacuum Oil Company as an Aviation Engineer.

Walter H. Buchman is now Assistant Professor and Aeronautical Engineering Coordinator at the University of Cincinnati.

Harold E. Carlson has joined Boeing Aircraft Company as an Engineer in the Aerodynamics Unit.

James R. Carnwath is now an Engineer and Designer at Pacific Car and Foundry.

William J. Cecka, Jr., has joined North American Aviation, Inc., as a Laboratory Research Analyst.

Archie T. Chapel is now a Layout Engineer at the Wichita Division of Boeing Airplane Company.

G. A. Connor has joined Douglas Aircraft Company, Inc., as a Design Engineer.

George V. Constantakis is now an Engineer at the United States Rubber Company.

Herbert O. Cox has joined Aerojet Engineering Corporation as an Instrumentation Engineer.

Ronald E. Crandall is now an Engineering Designer at Northrop Aircraft, Inc.

Mario DiGiovanni has joined the Stewart Technical School as Chief Engineer.

Leon L. Douglas is now Chief Structural Engineer at Kellett Aircraft Corporation.

William J. Eaton has joined the Experimental Engineering Section of Grumman Aircraft Engineering Corporation.

Harry S. Egerton is now an Instructor at the Academy of Aeronautics, Inc.

Ken Ellington has been elected Chairman of the Eastern Region Public Relations Advisory Committee of the Aircraft Industries Association.

Francis H. Erdman has joined McDonnell Aircraft Corporation as a Design Engineer.

Merle O. Evers is now a Stress Analyst at the El Segundo Division of Douglas Aircraft Company, Inc.

Thomas J. Ferrell has joined American Air Filter, Inc., as an Engineer.

Walter J. Forster is now an Aeronautical Engineer at Lockheed Aircraft Corporation.

Gordon L. Freedman is now President of Freedman Aircraft Engineering Corporation.

William J. Furlick has joined Aeronca Aircraft Corporation as a Service Engineer.

Perry L. Gardner is now a Student at Rensselaer Polytechnic Institute.

James A. Gean has joined Traverse Bay Manufacturing Company as a Design and Development Engineer.

Alexander Goldberg is now a Major Layout Designer at Republic Aviation Corporation.

Irwin R. Goldsmith has joined the Kollsman Instrument Division of the Square D Company as an Assistant Engineer.

Ray G. Goodall is now a Structures Engineer at Lockheed Aircraft Corporation.

Robert B. Gorrill has joined Bendix Helicopter, Inc., as Chief Test Pilot.

Leroy R. Grumman, formerly President of Grumman Aircraft Engineering Corporation, has been elected Chairman of the Board.

Sergei G. Guins is now Consulting Engineer to the National Bronze & Aluminum Foundry Company.

Karl H. Guttmann has joined the Ranger Aircraft Engines Division of Fairchild Engine and Airplane Corporation as a Design Engineer.

Charles W. Guy is now a Research Engineer at North American Aviation, Inc.

Charles O. Harris has been appointed Chairman of the Department of Engineering Mechanics at the University of Notre Dame.

Robert Haskins, Jr., has become President of the Flight Research Engineering Corporation.

Milton DeV. Hunnex is an Instructor in the Jet Propulsion School of the Civilian Training Branch of the Air Matériel Command at San Bernardino, Calif. He is also an Instructor in Aeronautics at the San Bernardino Valley Junior College.

Francis W. Hutchinson has been named Consultant to the Minneapolis-Honeywell Regulator Company.

Roy P. Jackson is now an Aerodynamics Engineer at North American Aviation, Inc.

Ferdinand L. Jesse has joined the Fisher Body Division of General Motors Corporation as a Senior Layout Draftsman.

William S. Johnston is now a Partner and General Manager in his own firm, Distributor for the Cadillac Motor Car Company, at Trenton, N.J.

C. S. Jones has become Acting New York State Wing Commander of the Air Force Association.

J. Byron Jones has been advanced to the post of Head of the Aerophysics Department of the Goodyear Aircraft Corporation.

Everett L. Kelly is now Professor of Psychology at the University of Michigan.

William D. Kennedy, Vice-President and General Manager of Wright Aeronautical Corporation, has been named a Director of Canadian Wright Limited.

John Kleissas has joined Northrop Aircraft, Inc., as an Aerodynamicist "A."

Bradley G. Kohr is now a Senior Weight Engineer at The Glenn L. Martin Company.

Robert K. LeBeck has joined the Aerodynamics Department, Engineering Division, of North American Aviation, Inc.

Robert C. LoPiccolo is now a Draftsman, Airframe Design, at The Glenn L. Martin Company.

Lee R. Malmsten has become a Consultant to the Embry-Riddle Company.

Kenneth D. Miller is now a Research Associate in the Department of Aeronautical Engineering at Princeton University.

Peter J. Minniti has joined the firm of Frank Judge Maher as Sales Manager.

Bruce Mitchell is now a Stress Analyst "A" at Northrop Aircraft, Inc.

Daniel F. Murnane has joined Cowles Engineering Company as an Engineer.

Clifford L. Muzzey is now an Engineer in the Instrument Laboratory at Massachusetts Institute of Technology.

Philip F. Myers has joined Taylorcraft Aviation Corporation as a Stress Analyst.

Richard T. Nalle, Jr., is now a Test Engineer in the Gas Turbine Division of Westinghouse Electric Corporation.

Ben A. Neffson has joined North American Aviation, Inc., as a Stress Analyst "A."

Wilbur C. Nelson, formerly Head of the Aeronautical Engineering Department at Iowa State College, has been appointed Professor of Aeronautical Engineering at the University of Michigan, in charge of the Aeronautical Research Program.

Bergen F. Newell is now Advertising Production Manager at Cline Advertising Service.

Samuel G. Nordlinger has joined the Ranger Aircraft Engines Division of Fairchild Engine and Airplane Corporation as Chief of Unconventional Power Plants Engineering.

Frederick S. Nowlan, Jr., is now an Aeronautical Engineer at United Air Lines, Inc.

George B. Pegram, Dean of the Graduate School at Columbia University, has been chosen a Trustee of Associated Universities, Inc., a Federal project for research in nuclear physics.

Bernard L. Prenovich, formerly Chief of Structures, Sikorsky Aircraft Division of United Aircraft Corporation, is now a Bridge Engineer with the firm of Dr. David B. Steinman.

Daniel R. Ranney has joined the Piasecki Helicopter Corporation as Structural Design Engineer.

Joseph A. Readey is now a Research Assistant at the Fritz Engineering Laboratory of Lehigh University.

James F. Reagan has joined the Special Development Products Section of the Pacific Division, Bendix Aviation Corporation.

I. F. Richardson has become Assistant Sales Manager of the Aviation Products Group, Bendix Products Division, Bendix Aviation Corporation.

Rear Admiral L. B. Richardson, Deputy and Assistant Chief of the Navy Bureau of Aeronautics, will become Executive Assistant to the President of the Curtiss-Wright Corporation.

Phillip H. Roberts is now Assistant Controls Group Engineer at Boeing Airplane Company, Wichita Division.

Emile J. Schaeffer is now a Senior Aeronautical Engineer in the A & R Engineering Division, U.S. Marine Corps.

Kenneth H. Schultz has joined Boeing Airplane Company as a Stress Engineer.

Jean C. Schwarzenbach has resumed the Presidency of U. S. Propellers, Inc.

William T. Schwendler, formerly Vice-President and Chief Engineer of Grumman Aircraft Engineering Corporation, has been elected Executive Vice-President and will continue as Chief Engineer.

William B. Shepard has joined G & A Aircraft, Inc., as Project Engineer.

Lee H. Smith has returned to the Aeronca Aircraft Corporation as Executive Vice-President.

Athelstan F. Spilhaus has returned from military service as an officer in the A.A.F. to New York University as Professor and Director of Research and Chairman of the Department of Meteorology.

Warren A. Stauffer has joined Lockheed Aircraft Corporation as a Stress Analyst.

John A. Stern is now an Aeronautical Engineer at United Air Lines, Inc.

James A. Sullivan has joined Edo Aircraft Corporation as Flight Test Engineer.

Fen C. Taylor is now an Aerodynamicist at Northrop Aircraft, Inc.

Cyril C. Thompson has joined American Aviation Associates, Inc., as Aviation Consultant and Director.

William W. Thomson is an Experimental and Development Engineer at Wilson-Zuck Aircraft Company.

Paul C. Thornbury has joined the Civil Aeronautics Administration as a Flight Engineering Inspector.

Kermit E. Van Every has been appointed Chief of the Aerodynamics Section of the El Segundo Engineering Department, Douglas Aircraft Company, Inc.

Charles W. Von Rosenberg is now Superintendent of the Aircraft and Components Branch of the Civil Aeronautics Administration.

William Wait, Jr., formerly Chief Salvage Engineer at Republic Aviation Corporation, has joined Evans-Mar Corporation as Chief Engineer.

John M. Warner has joined British European Airways as Analysis Engineer.

H. Hugh Willis has been appointed Director of Research, Engineering, and Product Development of Eversharp, Inc.

H. Dudley Wimer, Jr., has received the second award in the Billin Award Contest for his paper titled "Stress Analysis of Open Shell Type Structures Subjected to Torsion."

Emmett A. Witmer is a Graduate Student at The Pennsylvania State College.

Stephen E. Woodbury has joined the Submarine Signal Company as Senior Electronic Engineer.

Leon R. Wosika is now a Gas Turbine Design Engineer at Solar Aircraft Company.

Walter Wrigley has joined the Massachusetts Institute of Technology as Technical Assistant to the Director of the Instrumentation Laboratory.

Roy A. Wulff is now a Senior Stress Analyst at The Glenn L. Martin Company.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Duke, William Meng, M.S. in Ae.E.; Asst. Dept. Head, Cornell Aeronautical Lab.

Kibardin, Victor M., M.S.E. in Ae.E.; Supervisor in the Electronic Trainer Dept., Propeller Div., Curtiss-Wright Corp.

McClellan, Stephen A., Sc.B.; President, Specialties, Inc.

Sears, William Rees, Ph.D.; Director, Graduate School of Aeronautical Engineering, Cornell University.

Strom, Gordon Haakon, M.S. in Ae.E.; Asst. Professor of Aeronautical Engineering, New York University.

Elected to MEMBER Grade

Addison, Floyd, Capt., (First Pilot) Delta Air Lines, Inc.

Alexander, Nicholas, Professor of Aeronautical Engineering, Rhode Island State College.

Andes, Ammon S., M.S.; Aerodynamicist and Research Lab. Analyst, Consolidated Vultee Aircraft Corp.

Baldes, Edward James, Ph.D.; Professor of Biophysics, Mayo Clinic.

Bartlett, Parker Morse, B.S. in M.E.; Power Plants Division, Bureau of Aeronautics, Navy Dept.

Bransford, Carroll Keister, B.S. in M.E.; Lt., U.S.N.R.

Carl, Robert Arthur, B.S. in M.E.; Lt. Comdr., Acting Head, Structural Development Section, U.S. Navy.

Chambers, Lester Smith, M.S.; Comdr., Head of Aeromechanics Div., David Taylor Model Basin, U.S. Navy.

Clement, George Herbert, B.S.; Engineering Designer, Douglas Aircraft Co., Inc.

Cox, William Theodore, M.S. in C.E.; Head, Contract Structural Design Section, Bureau of Aeronautics, Navy Dept.

Cumro, Dean George, Stress Analyst, Douglas Aircraft Co., Inc.

Dasteel, Robert Herbert, B.S.; Lt. Comdr., JRM (Mars) Project Officer, U.S. Navy.

Davis, Hunt, M.S. in M.E.; Section Engineer, Aerodynamics Section, Research and Development Dept., Elliott Company.

Derrom, Donald Laird, B.S.; Resident Consulting Engineer, Warren McArthur Corporation.

Eakin, Eugene Curtis, Stress Analyst, Douglas Aircraft Co., Inc.

Ennis, William Clare, B.S.; Program Analyst, Engineering Divisional Staff, Douglas Aircraft Co., Inc.

Ericson, Harold Louis, A.B.; Research Engineer, Douglas Aircraft Co., Inc.

Fellers, Walter Edwin, M.S. in Aeronautics; Project Aerodynamicist, North American Aviation, Inc.

Greene, Richard James, Comdr., U.S. Navy.

Grondona, Bennie Louis, B.S. in M.E.; Sr. Aeronautical Engineer P-5, Bureau of Aero. Repr., Consolidated Vultee Aircraft Corp.

Halitsky, Edward, Engineering Designer, Douglas Aircraft Co., Inc.

Hall, Russell Stewart, Engineer (Aircraft Gas Turbine Div.), General Electric Co.

Hall, William Norton, E.E.; Application Engineer, Elliott Company.

Harris, Charles DeWitt, B.S. in M.E.; Capt., Project Engineer, U.S. Army Air Forces.

Hertel, Courtney James, Chief, Production Design Section, Douglas Aircraft Co., Inc.

Hezel, Herman, Design and Development Engineer, Kollsman Instrument Div., Square D Co.

Hiersch, Frederick Alexander, B.S.; Sr. Project Engineer, AlFIN Corp.

Holden, Henry Robert, B.S. in C.E.; Administrative Engineer, Douglas Aircraft Co., Inc.

Hubbard, Richard Benson, B.S. in Ae.E.; Asst. Chief Engineer, Specialties, Inc.

Jackson, Harry William, A.B.; Stress Analyst, Douglas Aircraft Co., Inc.

Jackson, Robert Clay Prim, B.S. in M.E.; Asst. to Cost Analysis Engineer, Douglas Aircraft Co., Inc.

Jackson, Roy, B.S.; Capt., Director of Inspection, U.S. Navy.

Jerrold, Gilbert, Tech. Asst. to French Air Attaché, French Government (Air).

Jones, James Byron, B.S. in M.E.; Manager—Research and Development, Goodyear Aircraft Corp.

Keenan, Joseph Henry, S.B.; Professor of Mech. Eng., Massachusetts Institute of Technology.

Kleckner, Harold Francis, M.S.; Aerodynamicist "A," Douglas Aircraft Co., Inc.

Klocksiem, John Paul, B.S.; Engineering Designer, Douglas Aircraft Co., Inc.

Krebs, George William, II, Engineering Test Pilot, North American Aviation, Inc.

Leon, Hayden Louis, M.S.; Comdr., Asst. Director of Ships—Installations Div., Bureau of Aeronautics, Navy Dept.

Lopresti, Vincent Francis, Lt. Comdr., Electronic Engineer, Electronics Design Branch, Bureau of Aeronautics, Navy Dept.

Lukens, David Ellwood, Sales Engineer, Summerill Tubing Co., and Engineering Representative, Autogiro Co. of America.

Maclaren, Archibald Shaw, M.A.; Chartered Civil Engineer, own consulting practice (England).

Manatt, Walter Wilson, B.S. in M.E.; Designer, Douglas Aircraft Co., Inc.

Marsh, Elmer James, B.S. in Ae.E.; Research Group Engineer, Lockheed Aircraft Corp.

McCormick, Frank James, M.S.; Associate Prof. of Applied Mechanics, Kansas State College.

Miller, Arthur Edmund, Design Engineer, Scott Aviation Corp.

Miller, Ralph Blair, B.S. in Ae.E.; Aeronautical Engineer, Douglas Aircraft Co., Inc.

Mittler, Justi Lee, Interior Design Engineer, Douglas Aircraft Co., Inc.

Moss, Eric Beecroft, B.S.; Chief Engineer, S. Smith & Sons Ltd. (England).

Mueller, Carl Muth, B.S.; Aircraft Credit Analyst, Bankers Trust Company.

Mull, Lucius Sigel, B.S. in Ae.E.; Weight Control Engineer, Douglas Aircraft Co., Inc.

Oelschlager, Ray Troy, B.S.; Structures Engineer (Strength and Weights Section), Douglas Aircraft Co., Inc.

Oswald, Telford Wilbert, M.S. in Ae.E.; Aerodynamicist, Douglas Aircraft Co., Inc.

Pawl, Walter Stanley, Master of Patent Law; Patent Examiner, Bureau of Aeronautics, Navy Dept.

Pearson, Edgar Hamilton, Asst. Chief, Interiors Section, Douglas Aircraft Co., Inc.

Penfold, Harry Eric, Major, Asst. Air and Military Attaché for the Union of South Africa, South African Air Force.

Peterson, Ralph Henry, B.S. in M.E.; Comdr., Bureau of Aeronautics, Navy Dept.

Poulsen, August, Production Design Engineer, Douglas Aircraft Co., Inc.

Queyrel, Louis, A.A.; Asst. Administrative Engineer, El Segundo Div., Douglas Aircraft Co., Inc.

Radlett, Henry George, Sr. Aerodynamics Research and Project Design Engineer, Short Brothers Ltd. (England).

Rhodes, Edgar Peter, B.S. in Ae.E.; Asst. Chief Engineer, Ryan Aeronautical Co.

Richardson, Norval Ralph, Comdr., Head—Electronic Installation Branch, Bureau of Aeronautics, Navy Dept.

Roby, Jean Claude, Designer, The Glenn L. Martin Co.

Rose, Herbert, B.S.; Stress Analyst, Douglas Aircraft Co., Inc.

Samaras, Demetrios George O. M., Dr. Ing.; Research Engineer, National Research Council (Canada).

Schaffer, Bernard, B.S.; Asst. Chief Engineer, Greer Hydraulics, Inc.

Schirtzinger, Joseph Franklyn, Cost Analysis and Standards Engineer, Douglas Aircraft Co., Inc.

Schumacher, Lloyd Edgar, B.Ae.E.; Lt.—Design and Development Engineering and Pilot, U.S. Army Air Forces.

Scott, Charles Richter, B.S. in M.E.; Stress Analyst "A," Douglas Aircraft Co., Inc.

Sholes, Raymond Auten, Chief of Interiors Section, Douglas Aircraft Co., Inc.

Sinnette, John Townsend, Jr., M.S.; Physicist, Aircraft Engine Research Lab., N.A.C.A.

Stark, William Thomas, B.Ae.E.; Project Engineer, Wright Aeronautical Corp.

Stilson, Charles Edward, Jr., B.S.E.; Physicist, Cornell Aeronautical Lab.

Sturdevant, C. Victor, 3rd, M.S. in Ae.; Aerodynamics Engineer, Douglas Aircraft Co., Inc.

Sulzman, Edmund Chester, M.E.; Manager—Sales Div., Wright Aeronautical Corp.

Suydam, Wendell Wood, B.S.; Comdr., Head—Propeller and Propellered Engines Section (Power Plants Div.), Bureau of Aeronautics, Navy Dept.

Swanson, Alfred, B.S. in M.E.; Asst. Chief of Structures Section, Douglas Aircraft Co., Inc.

Teetor, Ralph R., M.E.; President, The Perfect Circle Company.

Teree, Baboo Ram, B.S. in Ae.E., B.S. n Eng. Math.; Project Engineer, The Weatherhead Co.

Thorngren, Alfred, Group Engineer, Douglas Aircraft Co., Inc.

Toth, Anthony, B.S in Ae.E.; Partner and General Manager, Auto-Plane Mfg. Co.

Way, Stewart, D.Sc.; Section Engineer, Thermodynamics, Westinghouse Electric Corp.

Weise, Carl Arthur, B.S. in Ae.E.; Power Plant Engineer, Douglas Aircraft Co., Inc.

Wetterau, Carl Robert, Production Engineer, Greer Hydraulics, Inc.

Whittier, Wilmot Lewis, Chief, Service Section (El Segundo Div.), Douglas Aircraft Co., Inc.

Transferred to MEMBER Grade

Davis, Craig Carlton, B.S. in General Eng.; Instructor, J. P. Riddle Company.

Flynn, Patrick Thomas, B.Ae.E.; Head of Gyro Instrument and Automatic Pilot Section, Bureau of Aeronautics, Navy Dept.

Goland, Martin, M.M.E.; Head of Engineering Dept., Midwest Research Institute.

Hayford, John Taylor, M.Ae.E.; Research Engineer, New York University.

Big Blow-up...

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Because it plays this dual role in electron micrography . . . because it both records and enlarges . . . photography is an integral part of the new technic that is adding so much knowledge of such tremendous value to many branches of industry.

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AMERICAN TUBE BENDING COMPANY, INC.

PRECISION to aircraft standards

Elected to Industrial Member Grade

Harjes, Charles Berwind, B.A.; President, The House of Travel, Inc.

Transferred to Industrial Member Grade

Ellington, Ken, Director Public Relations, Republic Aviation Corp.

Elected to Technical Member Grade

Gardiner, Frank John, B.Sc. in M.E.; Ensign, Aero-Thermodynamic Specialist, Bureau of Aeronautics, Navy Dept.

Graffy, Richard, B.E.; Lt., U.S. Navy.

Isenberg, Joel Saul, B.Sc.; Student—Research Assistant, Brown University.

Maxwell, Robert L., B.S. in M.E.; Lt., Pilot, Production Control Officer, U.S. Army Air Forces.

Rangaswamy, Salem Gopalaswamy, Sr., B.E.; Inspector in Charge Transport Aircraft, Messrs. Hindustan Aircraft Ltd. (India).

Rao, Gopala Krishnaswamy, B.M.E.; Liaison Engineer, Hindustan Aircraft Ltd. (S. India).

Raymond, Robert Perkie, B.S.; Experimental Inspector, McDonnell Aircraft Corp.

Riedhart, William Herbert, B.S. in Ae.E.; Flight Test Engineer, Curtiss-Wright Corp.

Rothman, Jack Edgar, B.Ae.E.; Asst. to Supt. of Eng. Development, United Air Lines, Inc.

Schwarz, Hans, B.M.E.; Intermediate Supercharger Engineer, Elliott Co.

Scott, John Amour, Structures Engineer, Fredric Flader, Inc.

Singer, Nathan, B.Ae.E.; Aerodynamicist, Republic Aviation Corp.

Sleeman, William Clifford, Jr., B.S. in Ae.E.; Aeronautical Engineer P-2, Langley Mem. Aero. Lab., N.A.C.A.

Stern, Marvin, B.M.E.; Stress Analyst, Republic Aviation Corp.

Tribus, Myron, B.S.; Research Asst., University of California.

Williams, Judge Keith, C.E.; Engineer in Charge of High Altitude Lab., Consolidated Vultee Aircraft Corp.

Elected to Affiliate Member Grade

Coney, William, Planner and Estimator, U.S. Navy.

Cross, Walter John, Materials Process Technician, Canadair, Ltd. (Canada).

Schoenfeld, Herbert Alfred, M.B.A.; Co-Owner, L. Schoenfeld & Sons.

Transferred from Student to Technical Member

Baker, Charles Lambert, B.S. in Ae.E.; Naval Engineer, Bureau of Aeronautics Representative, Chance Vought Aircraft Div., United Aircraft Corp.

Blattner, Calvin John, B.S.; Aero. Engineer, Assembly and Repair Dept., Naval Air Station (Jacksonville, Fla.).

Century, Bernard Amos, B.S. in Ae.E.; Ensign, Asst. Hangar Officer, U.S.N.R.

Chaudoin, Barney Alder, Jr., B.S. in Ae.E.; Mathematician "A," Douglas Aircraft Co., Inc.

Chawla, Jagannath Punnulal, M.S. in Ae.E.; Sr. Engineer, Flight Research, Cornell Aeronautical Lab.

Crilly, William Michael, B.S. in Ae.E.; Aerodynamicist, Douglas Aircraft Co., Inc.

Culwell, Fred Blaylock, Jr., B.S. in Ae.E.; Ensign, U.S. Navy.

DeGroff, Harold Miller, Jr., B.Ae.E.; Experimental Engineer and Detail Draftsman, Aeroproducts Div., General Motors Corp.

Dickson, William Thomas, B.Ae.E.; Ensign, U.S. Navy.

Goldbaum, George Charles, B.S. in Ae.E.; Mathematician, Aerodynamics Group, Douglas Aircraft Co., Inc.

Goodrum, Cloyd Smith, Jr., B.Ae.E.; Ensign, U.S. Navy.

Johnstone, Paul Meredith, Jr., B.S. in Ae.E.; Asst. Technical Officer, Ensign, U.S.N.R.

Lawsing, Joseph Woodrow, B.Ae.E.; U.S. Navy.

Ludwick, Richard Hand, B.S. in Ae.E.; Ensign, U.S. Navy.

Payne, Richard Leslie, B.Ae.E.; Engineering Duty Officer, U.S. Naval Air Transport Service, U.S. Naval Air Station (Patuxent River, Md.).

Pickford, Henry Winthrop, Jr., B.S.; Ensign, U.S. Navy.

Rinehart, Richard Dewey, B.Ae.E.; Research Engineer (Power Plant), Bell Aircraft Corp.

Schwan, Harold Charles, B.S. in Ae.E.; Asst. Technical Officer, U.S. Navy.

Strand, Donald Eugene, B.S. in Ae.E.; Ensign, U.S.N.R.

Tetens, Robert Chester, B.S. in Ae.E.; Ground School Instructor, U.S. Navy.

Witbeck, Norman C., B.Ae.E.; Graduate Student, Rensselaer Polytechnic Institute.

Necrology

Starr Truscott

Starr Truscott, a Fellow of the Institute and Chief of the Hydrodynamics Division of the National Advisory Committee for Aeronautics, died on July 17 at his home in Fox Hill, Va.

Born in Cleveland, Ohio, on April 27, 1886, Mr. Truscott attended Massachusetts Institute of Technology and received the degree of Bachelor of Science in Naval Architecture from the University of Michigan in 1909. He went to the Panama Canal in 1913 to work on the design and inspection of the lock caissons. He was made Chief Engineer of the Joint Army and Navy Airship Board in 1917, continuing in this post until its dissolution in 1920. From 1920 to 1926 he was Assistant for Lighter-than-Air, Bureau of Construction and Repair and Bureau of Aeronautics, Navy Department. In 1926 he joined the National Advisory Committee for Aeronautics as an Aeronautical Engineer, and since 1929 had been Chief of the Hydrodynamics Division at the Langley Memorial Aeronautical Laboratory.

Mr. Truscott assisted in the design of the dirigibles "Shenandoah," "Akron," and "Macon," and was responsible for the design of the first high-speed seaplane towing basin at the N.A.C.A. laboratory.

Arthur Warner Burwell

Arthur Warner Burwell, Vice-President and Technical Director of the Alox Corporation and an Associate Fellow of the Institute, died in Niagara Falls on May 24.

Born at Rock Island, Ill., on August 26, 1867, Dr. Burwell attended the Cleveland, Ohio, public schools and Kaiser Wilhelm's University, Strassburg, Germany, from which he received his Ph.D. degree in 1892. Upon his return to America, he began work on general petroleum refinery problems with the Standard Oil Company in 1893. Although largely concerned with petroleum, he also worked in the fields of electrode manufacture, electrolytic oxidation of organic compounds, and mineral separations. He developed compounding agents for blending with mineral oils to lubricate high-output aircraft engines and research equipment for investigations of compounded aviation oils.

Dr. Burwell was awarded the Schoellkopf Medal in 1941 by the American Chemical Society, in recognition of his fundamental work in the oxidation of petroleum and his studies in the theory of lubrication. He joined the Alox Corporation in 1926.

John S. Wynne

John S. Wynne, a Member of the Institute and legal counsel for many aviation interests, died on July 19 in St. Luke's Hospital in Washington, D.C.

Born in the capital city on May 11, 1898, Mr. Wynne attended Beaumont College, Windsor, England; Catholic University of America; Harvard University; Massachusetts Institute of Technology; The University of Clermont-Ferrand, France; and the National University School of Law.

(*Continued on page 29*)

Editorial

Men Wanted

Splitting atoms and bouncing radar beams off the moon have focused public attention on scientific research. These gaudier manifestations of technologic achievement have caught the fancy of the man in the street and have elevated the word "research" to a plane but a little lower than the angels'. They have also made it clear to the taxpayer that modern research is expensive. The fact that some two billion dollars had been spent on the atom bomb has apparently been accepted without any great outcry. People have begun to realize that it costs real money to progress in the more complicated scientific fields.

One of the more curious results of this shifting point of view has been the reversal of attitude on the part of the Congress of the United States toward appropriations for aeronautical research. In a recent hearing before the Senate Military Affairs Committee, the Chairman of the National Advisory Committee on Aeronautics was taken somewhat severely to task because the N.A.C.A. *had failed to ask the Congress for enough money for research* in the years before the war!

Times have certainly changed! How often in those days were research estimates cut to the bone by Congress or the Bureau of the Budget, or requests for new wind tunnels refused "because you already have a wind tunnel." Now, however, the Senatorial Fathers talk glibly of supersonics and of Mach Numbers and demand why they were not asked, years ago, for a dozen tunnels big enough and powerful enough to keep ahead of Germany's prewar V-2 development!

All of which is very much to the good, for the necessity for spending a considerably higher percentage of our national income for aeronautical research is increasingly obvious. The military needs are great. Also the requirements of the commercial air services should not be underestimated. Because of the pressure of war, the military airplane has been the direct beneficiary of research. Fortunately, many of the improvements that have resulted for fighters and bombers can be applied to the postwar air liner, but there are enough points of fundamental difference to warrant the diversion of a portion of the total research effort to the transport field. Our air liners will probably never push as close to the boundaries of maximum performance as will military types, but there are still vast fields to be explored in safety and economy and reliability of operation. Research along such lines will never be so spectacular as atom splitting but, in the long run, may well be equally important.

In whatever phase of aeronautical research, however, the greatest need is for MEN. Bigger and better research equipment is essential to progress, but the biggest wind tunnel in the world, or the most elaborate engine laboratory, or the fanciest electronic setup cannot be one whit better than the men who use it.

Today we are reaping the benefit of shortsighted education-for-research policies of the prewar decade. We do not lack adequate research facilities, but we do suffer from a shortage of high-grade engineering talent to man them. It takes many years to develop a Kettering or a Steinmetz, and there are few men of such caliber in sight in aeronautical research today.

The Institute of the Aeronautical Sciences has a definite responsibility in this situation. As a professional society, it has an obligation to keep its membership posted on current research developments from all over the world. It must participate in every worthwhile effort toward the advancement of aeronautical engineering education. It must recognize and honor every outstanding contribution to knowledge in the aeronautical sciences. By every possible means it must foster and encourage the men of vision within its ranks in their march toward a limitless future.

The new N.A.C.A. 12-Ft. Wind Tunnel

Automatic Pilots—Past, Present, and Future

ROBERT L. JOHNSON*

Navy Department

SUMMARY

The performance characteristics of past and current automatic pilots are given and the essential features of their historical development are pointed out. The changing status of the automatic pilot from a luxury to a necessity is emphasized and the increased range of application is reviewed. Specifications are given for an automatic pilot desired by the Navy for installation in the near future which are considered possible of achievement in the present state of the arts. Based on current requirements and the probable future of aircraft development, tentative performance specifications are given for an automatic pilot desired by the Navy during the next 5 years. The application of these pilots to commercial and private aircraft is discussed.

INTRODUCTION

A STATEMENT of the general requirement for any autopilot is easily made. It must provide control of the aircraft adequate for the purpose installed and it must do this with minimum weight and maximum reliability. A review of past and present installation purposes and the prediction of future installation purposes, when integrated with an overall view of the technical problems involved, should point out the path and a goal for future autopilot development. It is the function of this article to perform these tasks.

PAST AUTOMATIC PILOTS

The first conception of the purpose of an autopilot was that of pilot relief. By relieving the pilot of the tedium of routine flying, thus cutting down pilot fatigue, the pilot was not only made more comfortable but he was better able to apply himself to emergencies or other problems, such as navigation, search, etc. It is obvious that in order for the installation to be classed as other than a luxury it had to be justified on the basis of the fatigue-producing characteristics of the airplane and its mission.

NAVY TYPES S-1, S-3, AND S-4 AUTOPILOTS

Most important of the past autopilots were the Sperry S-1, S-3, and S-4 (formerly Marks 1, 3, and 4) designs. These were all of the pneumatic-hydraulic type—i.e., the "intelligence system," consisting of the gyros and the signal pickoffs, was air operated, while the "muscle system," consisting of servo pistons permanently connected into the control cables, was hydraulically operated at a pressure of about 100 lbs. per sq.in. Pertinent details concerning these autopilots are presented in Table 1. In general, the operating and performance characteristics of these three autopilots were quite similar. They were engaged by manually or hydraulically closing by-pass ports in the servos after manually aligning the signal pickoffs in the panel-mounted control units so that a maneuver would not be obtained upon engagement. This alignment of the pickoffs established the reference planes about which the airplane was controlled. Simple maneuvers could be performed by means of the pitch, roll, and rudder knobs on the control units which, when operated, rotated the respective pickoffs in the proper direction for the maneuver. Shallow dives and climbs and coordinated turns at low bank angles could be accomplished by proper manipulation of the three separate control knobs. During these maneuvers or during straight and level flight, adequate control of the airplane for comfortable flight was maintained in all but extremely rough air. Directional control was maintained by means of a modified directional gyro and therefore frequent (about every 15 min.) course corrections were necessary to compensate for gyro precession and drift. The control units were also used as indicating instruments and provided indications of horizontal and directional attitude of approximately the same size as the familiar air-driven directional gyro and gyro horizon, although the control units themselves were larger and thus somewhat wasteful of panel space. Figs. 1, 2, and 3 show the S-1, S-3, and S-4 control units. Figs. 4 and 5 show the servo unit used with the S-3 autopilot. Those used for the S-1 and S-4 were similar units. Individual pistons were sometimes used rather than three servos cast into a single unit as shown in Fig. 4.

As a relief for the pilot, these autopilots were considered a necessity in cargo planes, bombers, and other large aircraft. This was due, not only to the size of the aircraft involved, but also to their range, i.e., the long periods that they were in the air. Thus, for example, the Navy Catalina (PBY) and the Army C-47 (commercial DC-3) were both equipped with the S-1, and, later, the S-3 autopilots.

On the other hand, in only a few of the smaller aircraft was the autopilot considered a necessity. These airplanes were the SBD (Dauntless) and SB2C (Helldiver) models employed in long, lone, monotonous search flights from carriers. The lighter, smaller, S-4 autopilot was installed in these planes. However, there was continual discussion on the advisability of these installations. The control units were large in comparison to the other instruments and complicated the instrument panel. Violent maneuvers always resulted in tumbled gyros. Many of the missions were of short duration and did not require the use of an autopilot. As the massed carrier-plane flights of the Pacific war became standard procedure and long search flights by single carrier planes became less frequent, the autopilot was used less and less. This was because of the fact that the S-4 autopilot could not be satisfactorily maneuvered in formation flights. Therefore, it was removed because it could no longer justify the weight of the installation.

The above discussion covers those autopilots that were of importance during the decade of the thirties. The year 1940 provides a logical point at which to turn to the consideration of present autopilots since most of those designed after that date are now in use.

R. L. Johnson.

PRESENT AUTOMATIC PILOTS

The requirement for an autopilot to relieve pilot fatigue continued and other autopilots were designed for this purpose. Naturally, improvements were made. During 1942 and 1943, General Electric designed and produced the Navy Type G-1 autopilot. In 1943 and

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TABLE 1
Design Details of Various Autopilots*

	Navy S-1	Navy S-3	Navy S-4	Navy G-1	Navy P-1	Army C-1	Army A-5	Army A-12	Navy GR-1	1-Year Goal	5-Year Goal
Uninstalled weight—lbs.[1]	66	55	41	63	73	157	167	106	28	63	46
Type of gyro power	Air	Air	Air	Elec.	Elec.	Elec.	Elec.	Elec.	Air	Elec.	Elec.
Type of signal pickoff	Air	Air	Air	Elec.	Elec.	Elec.	Elec.	Elec.	Air	Elec.	Elec.
Type of servo power	Hyd.	Hyd.	Hyd.	Hyd.	Elec.	Elec.	Elec.	Elec.	Hyd.	Elec.	Elec.
Size—panel mounted units—in.											
Directional unit	8.7 by 5.1	7 by 5	6.8 by 4.5	6.8 by 4.5	2.75 D	None	None	2.75 D	4.5 by 5.7	Any desired size or type	
Horizontal unit	8.7 by 8.8	7 by 7.5	6.8 by 5	6.8 by 5	2.75 D	None	None	None	4.6 by 4.6		
Gyro tumbling limits—degrees											
Directional unit—bank	50	55	55	60	110	40	60	85	55	None	None
Directional unit—pitch	50	55	55	60	70	40	60	85	55	None	None
Horizontal unit—bank	40	50	90	90	100	40	60	85	100	None	None
Horizontal unit—pitch	25	50	55	60	85	40	40	85	70	None	None
Maneuvering limits—degrees											
Bank—right or left	30	30	25	30	60	40	50	45	45	70	None
Pitch—up or down	18	20	18	20	20	40	30	20	50	70	None
Altitude limit—ft.	25,000	25,000	25,000	50,000	50,000	[3]	40,000	50,000	25,000	60,000	60,000
Low temperature limit—°C.	0	−35	−35	−35	−54	−12	−60	−60	−35	−54	−54
Directional control—gyro or magnetic	Gyro	Gyro	Gyro	Gyro	Mag.	Gyro	Gyro	Mag.	Gyro	Mag.	Mag.
Number of maneuvering controls	3	3	3	3	1	1	1	1	1	1	1
Amount of 115-volt, 3-phase, 400-cycle power required—va.	None	None	None	115 @ 0.9 P.F.	250 @ 0.9 P.F.	[2]	375 @ 0.8 P.F.	190 @ 0.9 P.F.	None	Total a.c. and d.c. power not to exceed 250 watts	
Amount of 28-volt d.c. power required—amp. max.	None	None	None	1	4	7	25	21	Neg.		
Pickoffs automatically synchronized	No	No	No	No	Yes	No	No	Yes	Yes	Yes	Yes
Servos engaged when autopilot off	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No

* Where there is more than one version under the same general designation, data are given for lightest version.
[1] See Table 2 for more accurate conception of weight comparison.
[2] Requires 19-volt, 105-cycle, 1-phase power. 25 va.
[3] Dependent on temperature.

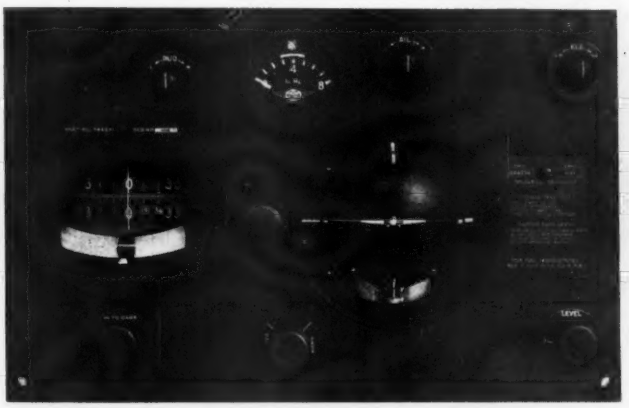


Fig. 1. Type S-1 autopilot gyro control units.

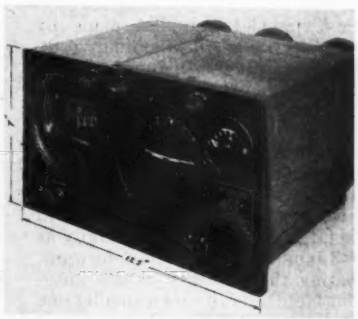
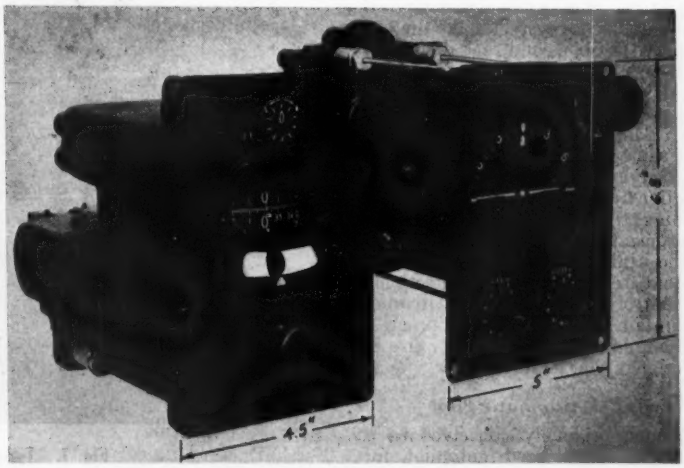


Fig. 2 *(above)*. Type S-3 autopilot gyro control units.

Fig. 3 *(below)*. Type S-4 autopilot gyro control units.

1944 Pioneer put out the Navy Type P-1 autopilot, and in 1944 and 1945 Sperry followed with the Army Type A-12 autopilot. In the meantime, however, a purpose requiring another feature in automatic pilots had arisen. This was the stabilization of bomber aircraft under control of the bombsight during the bombing attack. Precision bombing required precision control. To meet these needs the Bureau of Ordnance sponsored the development of the Norden SBAE (Stabilized Bombing Approach Equipment) during 1933 and 1934. In 1941 the Army had Minneapolis-Honeywell modify the Norden SBAE to improve its performance and gave the modified autopilot the designation Type C-1. At approximately the same time the Army had Sperry develop the Type A-5 autopilot. De-



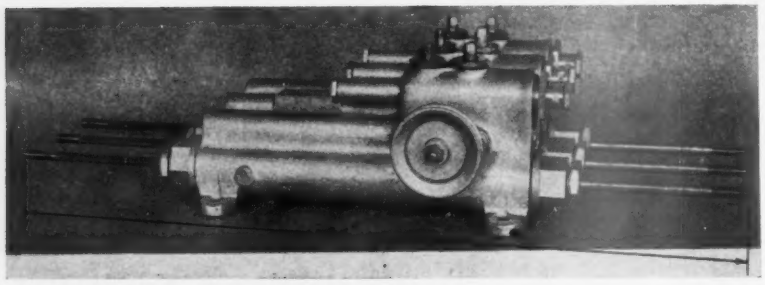


Fig. 4. Type S-3 autopilot servo unit. Eight-inch stroke, 3 bank for aileron, rudder, and elevator.

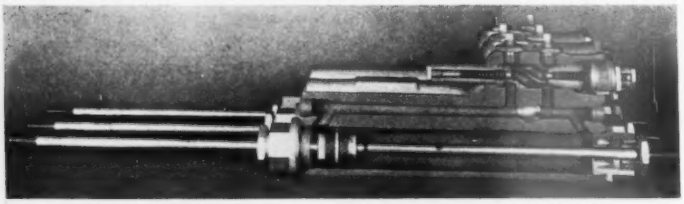


Fig. 5. Cutaway view of servo shown in Fig. 4

tails concerning these newer autopilots are presented in Table 1.

Navy Type G-1 Automatic Pilot

The Type G-1 autopilot made by General Electric is still essentially a relief autopilot. It uses many of the hydraulic components of the S-4 autopilot. The primary difference is the change from an air-driven intelligence system to an electric-electronic system. It was designed for the heavier carrier aircraft that the S-4 autopilot would not handle. However, its design is such that it will handle large aircraft as satisfactorily as the S-3 and is thus a step forward, eliminating the necessity of one autopilot for large aircraft and a smaller one for small aircraft. The change to an electric intelligence system is also a step forward. Longer gyro life results because dirt and moisture-laden air is not being drawn through the instrument where the dirt collects and the moisture condenses. This problem is particularly acute and has been most troublesome in the tropics. Electronic signal circuits in the intelligence system make the G-1 autopilot flexible, and a satisfactory interconnection with the bombsight has been developed although the autopilot was not originally designed with this in mind. Maneuvering is accomplished in the same manner as the S-4 autopilot and, therefore, it is unsatisfactory for formation flying. Engaging procedures, including the requirement of manual synchronization of the signal pickoffs, are the same as in the S-4 autopilot. Constant resetting of the directional gyro control unit is still required in order to maintain direction. Little progress was made in reducing weight or size in the design of the G-1 autopilot.

Navy Type P-1 Automatic Pilot

Although originally conceived as a lightweight, small-sized autopilot for use in all sizes of aircraft, the Pioneer all-electric-electronic Type P-1 autopilot emerged from the design stage as a relatively heavy autopilot (73 lbs. in the lightest version). However, it retains small sizes in the critical panel-mounted control units and, in general, is a decided improvement in autopilots. No manual synchronization of the signal pickoffs is required before engaging since they are automatically synchronized. The autopilot can be engaged in any attitude approximating level flight ($\pm 10°$ bank or pitch) and the airplane will be maintained in that attitude unless returned to level flight by the use of the controller. Maneuvers are easily made, coordinated turns by means of a single controller knob, and dives and climbs by means of another knob on the controller which is a separate unit and not a part of the control units. Fig. 6 shows this type of controller. Several stick-type controllers incorporating control of all maneuvers into a single miniature control stick have been designed to replace the two-knob type controllers. Maneuvering limits are given in Table 1. The panel-mounted gyro-horizon control unit and master direction indicator are in standard AN $2^3/_4$-in. size cases, thus helping considerably the problem of panel layout and standardization. Fig. 7 shows these panel-mounted control units. Direction is controlled by a gyro Flux Gate compass, so that constant course setting is not required. Being entirely electric, any interconnections with other equipment are easily made. For example, an interconnection with the Norden bombsight has been made which tests have shown gives bombing results that equal those of other interconnections with optical bombing equipment. The servos are the rotary type rather than the piston type. A typical servo is shown in Fig. 8.

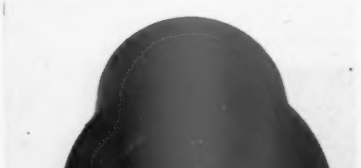


Fig. 6. Type P-1 autopilot controller.

Army Type A-12 Automatic Pilot

From an overall standpoint, the Sperry Type A-12 and the Navy Type

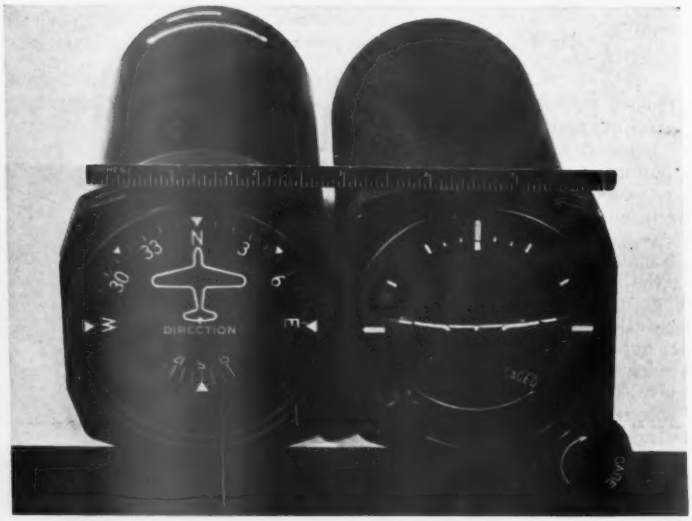


Fig. 7. Type P-1 autopilot control units.

P-1 autopilots are similar. The detailed methods of control accomplishment and design are, of course, quite different. The A-12 is all-electric-electronic, has automatically synchronized pickoffs, a coordinated turn and pitch controller, and is compass controlled. The compass control is obtained by means of a compass-monitored directional gyro rather than a Flux Gate compass. An advantage of the former is the smaller size of the remotely mounted magnetically sensitive element due to the fact that it does not contain a gyro. Figs. 9 and 10 show the relative size of the two units. No panel-mounted horizontal attitude indicator is provided. However, remote indicators are being designed. Interconnections are easily made because of the flexibility of the electric circuits. Weight of the various components is 106 lbs. in the lightest version. From a military standpoint, application of the A-12, like the P-1, is limited to larger aircraft because of its weight and the lack of nontumbling gyros for indicating purposes.

Army Type C-1 Automatic Pilot

The new purpose of autopilot installations—accurate aircraft control for bombing—was filled first by the Norden SBAE (Stabilized Bombing Approach Equipment), an all d.c. electric system. Gyros, servos, and signal circuits were all operated from the d.c. system. This system was modified by the A.A.F. and Minneapolis-Honeywell to make the signal circuits a.c. and was given the designation Army Type C-1. The advantages of a.c. over d.c. signals are smoother, more sensitive control and a more flexible intelligence system through the use of electronics. Since precision control of the aircraft was essential, weight and size reduction did not bulk too large in design considerations and the result is a rather heavy autopilot (154 lbs.). However, the bombing results obtained have more than justified the weight. There are no panel-mounted indicators included as an integral part of this autopilot, the gyros being mounted in any convenient part of the aircraft. Manual synchronization of the signal pickoffs is required; in fact, the number of adjustments that the human pilot must make to insure proper flight control, combined with the adjustments made prior to engagement, constitute one of the drawbacks of the C-1 autopilot. The control panel is imposing. Coordinated turns may be made by means of a single knob. A miniature stick-type control has been designed in order to allow easier maneuvering.

Army Type A-5 Automatic Pilot

Another autopilot designed expressly for bombing purposes is the Sperry A-5. It is all-electric-electronic except for the servos, each of which includes a self-contained hydraulic system. It, too, is a heavy autopilot (169 lbs.), again the result of desiring to insure a comfortable margin of precision control. Manual pickoff synchronization is required before engagement. Although intended to supplant the C-1 autopilot, unsatisfactory operation caused primarily by maintenance problems on the complicated signal system resulted in its being discarded.

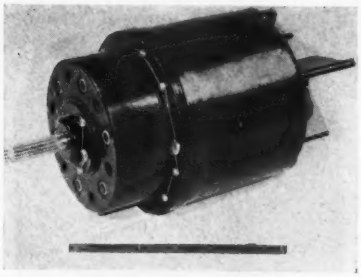


Fig. 8. Type P-1 autopilot servo unit.

Fig. 9. Type A-12 autopilot flux valve—the remotely mounted magnetically sensitive element.

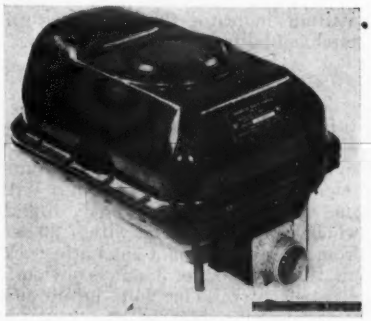


Fig. 10. Type P-1 autopilot Flux Gate transmitter—the remotely mounted magnetically sensitive element.

Future Automatic Pilots

Toward the end of World War II many new uses for autopilots arose. In some cases existing autopilots could satisfy the requirements but, in most cases, the story went, "If the autopilot could do this, that, and the other thing, we could use it." One of the first of these new uses arose through the increased extent of night fighter operations. An autopilot was required which would hold the aircraft in a set attitude or rate of turn and still permit easy maneuvering when required, thus allowing the pilots to devote full attention to the immediate problems—radio procedure, and visual and radar-scope search for the enemy target. For fighter installation, light weight and small size are essential. For night work, dependability and safety features are required. A most obvious safety feature is a control which, when operated, will return the aircraft, whether initially under control of the autopilot or not, to approximately level flight. Pilots suspecting vertigo or unable to recover by reference to their instruments could simply operate the button or lever and be returned to level flight automatically.

New Uses for Automatic Pilots

Considering the use as a maneuvering autopilot as use number (1), the list of new uses for autopilots can be continued as:

(2) Interconnection with the radio altimeter in order to maintain the aircraft at a given absolute altitude for use in torpedo attacks, low-altitude patrols over water, etc.

(3) Interconnection with blind landing devices in order to land the aircraft automatically under low visibility conditions, thus resulting in fewer cancellations of commercial or military flights due to weather.

(4) Interconnection with radio and radar homing devices, both for military offensive purposes and for navigation purposes. (In regard to these interconnections between autopilots and the various electronic devices, it is noted in passing that a program for standardization of the various signal outputs required is under way within the armed forces. For example, it may be decided that for angular deviations between the controlled and controlling equipment the output signal should be 0.10 volt per degree across an impedance of 500 ohms. One device would then have to put out that signal while the other would be required to make use of it. Such a standardization would greatly simplify the problem of interconnections.)

(5) Interconnection with the barometric altimeter in order to maintain flight at a constant pressure altitude over both water and land. This is important from a safety standpoint and is closely linked with problems of airway traffic control.

(6) Some devices in aircraft require an electrical azimuth or horizontal reference, either for actual stabilization of equipment such as antennas or for use in computing circuits. While the supplying of the electrical information for these purposes does not require an autopilot, the information required is available in the system and, in the interest of weight-saving, it seems desirable to make provisions for supplying it where feasible. Devices that might conceivably require such "information" or stabilization are radar antennas, radar scope systems, radar calculation systems, drift sights, bombsights, etc.

Other Considerations

There are two systems in aircraft which are closely linked with autopilot systems and whose incorporation into an autopilot system designed to fulfill the requirements discussed immediately above is considered to be desirable. They are the magnetic compass system and the flight instrument (attitude indicating) system. The autopilot requires a directional reference, preferably one free from gyro precession and drift. Such a reference is provided by a stabilized remote indicating compass system and, for this reason as well as in the interests of weight-saving, it is considered desirable to combine the compass and the autopilot systems. (A stabilized remote indicating compass system is one in which (a) the magnetically sensitive element is mounted in a wing tip, tail, or other part of the aircraft where magnetic deviations are small, and (b) includes a means of stabilizing the compass reading so that maneuvers or random oscillations do not cause incorrect compass readings. Existing stabilized compasses accomplish this either by mounting the sensitive element on a horizontal gyro or by integrating the magnetic heading signals by means of a directional gyro.) Both the flight instrument and the autopilot systems require a horizontal reference. Therefore, again in the interests of weight-saving, it is considered desirable to combine these two systems.

Combination of Flight Instrument, Compass, and Automatic Pilot Systems

Combining the compass and autopilot systems presents no great problem. The integrating gyro or master indicator of stabilized remote indicating compass systems is, or can be, mounted in some place other than directly on the instrument panel and remote indication of compass heading provided on the instrument panel. Autopilot signal pickoffs can then be placed in the integrating gyro or master indicator units. However, combination of the autopilot and flight instrument systems, when approached with the conventional idea of placing the gyro units on the instrument panel, becomes more difficult. Panel space is precious, particularly in single control combat aircraft where gun sights, radar scopes, and instruments vie for favored position. The technical problems of designing a small gyro with the universal freedom now required and with pickoffs for the autopilot and perhaps other devices is imposing. However, even more serious a limitation is the relative inflexibility of the type of indication possible when the gyro itself is used as an indicator. The conventional horizon bar moving with respect to a fixed miniature airplane and the stabilized sphere of the universally mounted gyro horizon are familiar types of attitude indication. Each has its limitations and considerable thought is now being given to other types of indication that present a more natural or more condensed picture of aircraft attitude. In all of these new types remote indication of roll and pitch greatly simplifies the design of the indicator, as well as making practicable many more types of indication. Therefore, in combining the flight instrument and autopilot systems, the use of remote indication is considered to be desirable since it solves the problems of both size and flexibility of indication. Autopilot pickoffs are easily placed on the remote gyro. Fig. 11 illustrates one proposed type of remote attitude indicator that combines roll, pitch, and direction in one indicator.

Fig. 11. One type of proposed combination roll, pitch, and direction indicator.

Quick Gyro Erection

Present gyros require from 2 to 3 min. to reach an equilibrium position so that they can be used as a horizontal reference for attitude indication. With the advent of jet-powered aircraft which can be air-borne within 30 sec. from the time the pilot enters the cockpit, this lapse of 2 or 3 min. is obviously unsatisfactory. Therefore, future gyro references must provide some means of erecting the gyro to the horizontal position within 30 sec. from the time power is applied to the gyro. Only then will a reliable reference be provided for instrument take-off conditions.

Fig. 12. Type GR-1 autopilot controller.

Other Indication Methods and References

The foregoing discussion applies, of course, only to those indicators using "artificial" references as a basis for indication. It must be remembered that radar or other such devices may some day present a picture of the actual surroundings making "artificial" references unnecessary.

Another point that should be mentioned at this time concerns the fact that the preceding discussions and the discussion that follows assume that the reference planes are maintained by gyros. This may not be true in the future. However, for the purposes of this discussion the method of obtaining the reference planes is unimportant as long as the overall requirements of weight, size, accuracy, etc., are met.

Disengaging Compass Control at High Latitudes

In high latitudes magnetic compass direction becomes an unreliable direction reference. Inasmuch as polar navigation is becoming more and more important, it is considered desirable to provide means for disengaging the compass control at high latitudes and using the gyro as the directional reference for the autopilot.

Navy Type GR-1 Automatic Pilot

Within the next 6 months an autopilot designed to meet the first of the above-mentioned new needs will be in service in Navy aircraft. This is the type GR-1 autopilot made by the Grumman Aircraft Engineering Corporation. Designed to meet the need quickly, it makes use of standard AN air-operated gyro instruments modified to include signal pickoffs that are also air operated. The hydraulic power control is operated from the main aircraft system at system pressure. Fairly comfortable maneuvers are obtained by means of a miniature stick-type controller illustrated in Fig. 12. Pickoffs are self-synchronized and the autopilot may be engaged in any attitude within the maneuvering limits and the aircraft will be maintained in the existing attitude or rate of turn. A second position of the engaging control returns the aircraft to approximately level flight. As a result of using the main aircraft hydraulic system as a power source, the weight of the servos and accessories is greatly reduced and an extremely light autopilot (28 lbs.) is obtained. Although maneuvering is accomplished by means of small d.c. motors operating the pickoffs, the system is still essentially a mechanical one and, in order to obtain the flight characteristics noted above, is rather complicated. Therefore, maintenance difficulties are expected. Details concerning the GR-1 autopilot are presented in Table 1. However, as pointed out, the Type GR-1 satisfies the requirements of only one of the new uses and, therefore, can only be considered a

stopgap. The real problem is the design of an autopilot that is capable of fulfilling all requirements.

General Requirements

The subject of past and present autopilots having been reviewed, together with a discussion of possible future uses, a summary of the general requirements for future designs properly precedes the presentation of detail specifications.

On the basis of expected future uses, some of the requirements of an autopilot can be stated to be:

(a) Light weight.
(b) Dependability.
(c) Operative under any conceivable flight condition, so that the safety feature of automatic return to level flight may be realized and indications of aircraft attitude may be continually available to the pilot regardless of attitude.
(d) Operable in rapid maneuvers through a simple finger-tip control, in order to provide formation flying while on autopilot.
(e) Easily interconnected with other equipment, such as the radio altimeter, barometric altimeter, blind landing devices, and radio and radar homing.
(f) Capable of supplying an azimuth or horizontal reference for use in computing circuits or in the stabilization of other equipment.
(g) All-electric-electronic (except for possible self-contained hydraulic system in servos). Lack of hydraulic lines reduces aircraft vulnerability while the all-electric-electronic system increases flexibility of installations.

On the basis of improvement of the characteristics of existing or past autopilots, the list can be continued to include these requirements:

(h) Magnetically controlled in direction with the option of reverting to gyro control at high latitudes if desired.
(i) Equipped to provide remote indication of direction, pitch, and bank. With remote indication any style and almost any size of attitude indication can be obtained. This makes for greater flexibility in instrument and cockpit design.
(j) Capable of controlling aircraft of any size by changing only components of the "muscle" system, i.e., all sizes of aircraft will use the same compass and flight instrument components.
(k) Easily maintained.

As a general consideration, it must be remembered that future aircraft will be operating in the supersonic speed range. For this reason, consideration must be given to (a) reducing the time of response of the autopilot system, i.e., the time between the instant the aircraft begins to deviate from the desired flight path and the instant that the autopilot has taken adequate corrective action, and (b) adaptability of the servo system to new aerodynamic control systems.

The fulfillment of these general requirements should provide an autopilot, complete with compass and flight instrument systems, that would be not only desirable but usable in all types of conventional aircraft, large or small. There should be no further need for the design of special autopilots, such as the GR-1, C-1, and A-5.

Detail Specifications—5-Year Goal

A schematic presentation of the proposed system is indicated in Fig. 13. In the interests of clarity and space-saving the specifications are presented in outline form.

Compass System

(a) *Performance (accuracy).* Equal to or better than existing gyro Flux Gate compass system.
(b) *Reliability.* The compass is intended to replace both directional gyros and present remote indicating compasses. As indicated in Fig. 13, it consists of essentially three parts—the compass element, azimuth gyro, and indicators. The gyro and compass elements must be sufficiently independent to insure that, if the gyro fails, unstabilized compass indications will remain at the indicators and, if the compass element fails, directional gyro indications will remain at the indicators.
(c) *Weight.* Not to exceed 11 lbs. exclusive of indicators.
(d) *Size.* Compass element to be small enough to permit wing-tip installations. Size of other components to be as small as practicable.
(e) *Type of indication.* Any desired type is obtainable with the repeater type indication required.
(f) *Number of indicators.* Two remote attitude indicators (combination direction roll and pitch) for pilot and copilot and two direction repeaters for navigator, etc.
(g) *Interconnections.* Azimuth control of autopilot and azimuth reference for other equipment.
(h) *Power requirements.* 115 volt, 3 phase, 400 cycle a.c. Amount of power required shall be kept to a minimum in order to conserve weight of power-producing equipment.
(i) *Miscellaneous considerations.*
(1) Gyro shall be of the nontumbling universal type.
(2) It shall be possible to reset the gyro (or its indications) for use as a directional gyro in the event of compass failure.
(3) It shall not be possible to set the gyro (or its indications) in such a manner as to give incorrect compass headings when the compass element is operating, i.e., no 180° or 90° null points that give apparent coincidence between gyro heading and compass heading.
(4) Compensation shall be as readily and rapidly accomplished as in present compasses.

Flight Instrument System

(a) *Performance (accuracy).* As indicators, ±1° in pitch and in bank maximum permissible error. As a horizontal reference, ±$^1/_2$° in pitch and in bank.
(b) *Reliability.* Turn error, i.e., deviation of the gyro from horizontal caused during turns by the centrifugal acceleration action on the gravity erection mechanisms, shall be reduced or eliminated. The gyro shall be usable as a horizontal reference within 30 sec. after power has been applied to it.
(c) *Weight.* Maximum of: 7 lbs. for the gyro component; 3 lbs. for an indicator combining roll, pitch, and direction indicators; 1 lb. for a dive angle indicator.
(d) *Size.* Combination indicator—maximum of 5-in. square on instrument panel. Dive angle indicator—standard AN 2$^3/_4$-in. diameter case.
(e) *Type of indication.* Any desired type is obtainable with the repeater type indication required.
(f) *Number of indicators.* Two remote attitude indicators (combination direction, roll, and pitch) for pilot and

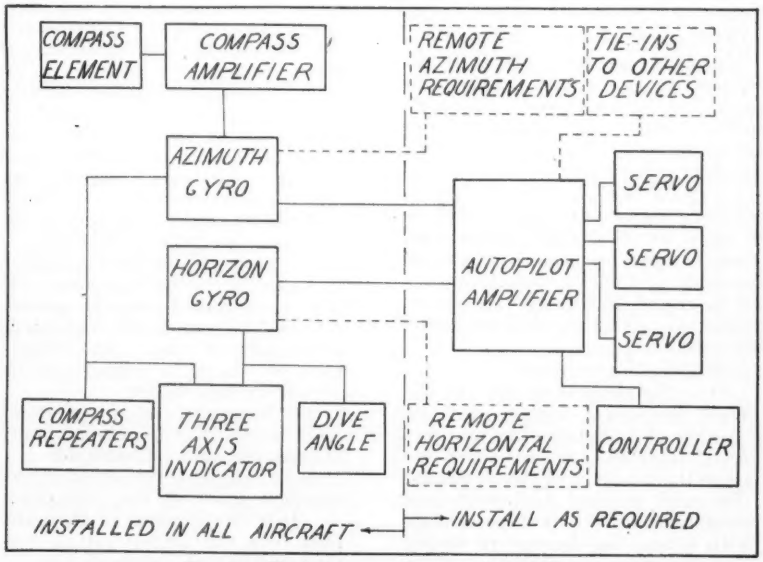


Fig. 13. Block diagram of proposed autopilots.

TABLE 2
Weight Comparison of Various Autopilots*

	Navy S-1	Navy S-3	Navy S-4	Navy G-1	Navy P-1	Army C-1	Army A-5	Army A-12	Navy GR-1	1-Year Goal	5-Year Goal
Compass system[1]	12	12	12	12	17.1	12	12	12.0	12	18	12
Direction intelligence system (if separate from compass system)	9.5	8.5	9.0	7.0	...	45.4	16.8	...	4.9	...	...
Horizontal intelligence system	16.8	13.5	8.0	9.0	3.1	18.3	29.5	7.0	12.3	7.0	7.0
Horizontal indication system (if separate from intelligence system)[2]	...	...	...	...	...	4.5	4.5	4.5	...	5.0	3.0
Power control system for light fighter—F6F	[3]	11.8	12.3	25.8	43.0	[3]	[3]	79.5	6 2	31.0	22.0
Power control system for heavy bomber—B-24	14.5	14.5	[4]	25.8	60.9	83.8	115	88.5	[5]	51.0	44.0
Accessories	24.8	21.3	12	20.7	10.0	10.0	5.6	7.5	4.3	2.0	2.0
Total weight—F6F	[3]	67.1	53.0	74.5	73.2	[3]	[3]	110	39.7	63.0	46.0
Total weight—B-24	77.6	69.8	[4]	74.5	91.0	174	184	119	[5]	83.0	68.0

* Weights given are uninstalled weights and are in pounds.
[1] For autopilots not incorporating a compass the weight of an existing compass-controlled directional gyro has been used.
[2] For autopilots not incorporating horizontal indication the weight of a standard air-driven gyro horizon has been used.
[3] Such an installation would never be made.
[4] Adequate control could not be obtained.
[5] No installation for large aircraft has been designed.

copilot, and three dive angle indicators for pilot, copilot, bombardier, radar devices, etc.

(g) *Interconnections.* Roll and pitch control of autopilot. Horizontal reference for other equipment.

(h) *Type of power.* Same as compass.

(i) *Gyro mounting.* To be of the nontumbling type.

Flight Control System

(a) *Performance (accuracy).* Precision control required for radar bombing, blind landing work, or formation flying.

(b) *Reliability.* Any failure within the system shall not cause a violent maneuver. It shall not be possible to engage the autopilot until it is in condition for complete and normal operation.

(c) *Weight.*

(1) Light Fighters, i.e., F6F: Servos not to exceed 4 lbs. each. Servo amplifier not to exceed 10 lbs. Controller not to exceed 2 lbs.

(2) Heavy Bomber, i.e., B-24: Servos not to exceed 10 lbs. each. Servo amplifier not to exceed 14 lbs. Controller not to exceed 2 lbs.

(d) *Interconnections.* Shall be capable of interconnection with blind landing devices, radar stabilization and computing devices, radio altimeter, barometric altimeter, bombsights, and radar and radio homing devices.

(e) *Type and amount of power.* 115 volts, 3 phase, 400 cycle a.c. and/or 28 volts d.c. For light fighter total power required for compass, flight instrument, and flight control systems not to exceed 250 watts. For heavy bomber the total power shall not exceed 500 watts.

(f) *Miscellaneous factors.*

(1) The compass system and the flight instrument system shall be capable of installation in any aircraft, regardless of size, which require the functions of these systems. The same physical components can then be used in any type aircraft with a resulting decrease in supply and maintenance problems. The flight control system will be an optional installation with the weight, size, and functions of the amplifier and servos varying from plane type to plane type.

(2) The servos shall be completely disconnected from the surface control system when the autopilot is off. This will reduce control surface friction and increase safety.

(3) The servos shall have only electrical connections leading to them although they may have a self-contained electric-hydraulic system. Lack of hydraulic lines reduces vulnerability of the system.

(4) Maneuvers throughout all flight attitudes are required in order to permit the automatic return-to-level-flight to operate. Maneuvers shall be comfortably performed regardless of air speed.

(5) Self-synchronizing pickoffs are required.

(6) All systems shall operate satisfactorily up to 60,000 ft. altitude.

(7) Automatic trim and indication of trim condition about all three axes should be incorporated so that a violent maneuver will not occur when the autopilot is disengaged, i.e., the autopilot may have sufficient power to hold the airplane in the desired attitude regardless of trim whereas the human pilot taking over upon disengagement would not. Considered from another angle the use of automatic trim would permit reduction in required servo power. Safety features to prevent runaway of the trim servo are to be incorporated.

(8) Gyros, transmitter, amplifiers, indicators, and other equipment subject to corrosion, fungus growth, etc., shall be hermetically sealed in an atmosphere of inert gas. Equipment life should be considerably increased by such sealing.

(9) Necessary safety interlocks shall be provided to prevent faulty manual operation of autopilot controls, i.e., engaging the autopilot with autopilot power off, etc. Overpower or quick disconnection of the autopilot from the aircraft surface controls shall be easily accomplished.

(10) Satisfactory operation shall be obtained through the temperature range of −54° to +70°C.

A comparison of the weights of existing autopilots and the "future" autopilot discussed above is presented in Table 2. So that a fair comparison may be provided, there has been added to the weight of existing autopilots the weight of additional equipment that must be installed in order to accomplish the same functions as the "future" autopilot.

SPECIFICATIONS TO BE MET WITHIN 1 YEAR

After consideration of the above specifications and the present state of the art, several contractors and the Navy have reached agreement upon specifications for an autopilot which can be met within the next year. Presented as deviations from the above specifications they are:

Compass System

(a) Sufficient independence of the gyro and compass systems to permit compass indications in the event of gyro failure, and vice versa, cannot be completely obtained.

(b) Weight will be closer to 18 lbs. than 11 lbs. mainly due to amplification stages included for remote indication of roll, pitch, and direction.

Flight Instrument System

(a) Turn error will still be present.

(b) Weight of a combination roll, pitch, and direction indicator will be closer to 5 lbs. than 3 lbs.

Flight Control System

(a) Weights.

(1) Weights for the small fighter servos will be closer to 7 lbs. than 4 lbs. This is due, primarily, to the weight of the means of detaching the servo from the control system when the autopilot is off and, secondarily, to the provisions made for easy removal for maintenance purposes.

(2) Weights for the heavy bomber servos will be closer to 12 lbs. than

10 lbs. and the servo amplifier closer to 15 lbs.

(b) Maneuvers through, and automatic recovery from, any flight attitude are not yet possible because of the complexity of the memory, analyzer, and sequence circuits involved. Maneuvers within, and automatic recovery from, attitudes up to ±70° roll and pitch are possible.

A comparison of the weights of this 1-year-in-the-future autopilot and existing autopilots is also presented in Table 2.

Application of "Future" Autopilot to Commercial and Private Aircraft

An autopilot conforming to the 5-year-goal specifications, and even to the 1-year-goal specifications, would have almost universal application in Navy and, presumably, Army aircraft. In fact, the accurate compass, small easily read flight instruments, and the maneuvering characteristics so necessary in long range and formation work, combined with the number of uses, both offensive and safety, to which this autopilot is adaptable make it a virtual necessity in most military aircraft.

These same considerations, with the exception of the purely military interconnections, such as bombsights, etc., apply equally as well to commercial aircraft. Adequate control with minimum weight and maximum reliability is still the goal. Safety, reliability, and all-weather operation possibilities provided by the various navigation and landing device interconnections mean as much to the efficient accomplishment of commercial schedules as they do to the successful accomplishment of military missions.

Use of this autopilot in private aircraft presents a somewhat different picture. In light, pleasure aircraft flown for convenience or for the enjoyment of flying, the need for an autopilot is not evident. Flights are normally of short duration and in good weather, so that fatigue does not enter the picture. The various radar and radio interconnections are not required. In general, it is believed that these considerations balanced against the cost in pounds and in dollars will not allow the installation of these autopilots in private aircraft.

Necrology

(*Continued from page 19*)

He received his pilot's license in 1927 and became General Manager of Hoover Field, Va., in 1931. In 1931–1932 he was Operations Manager at Washington-Hoover Airport. He joined the staff of the Bureau of Air Commerce in 1933 and became Chief of its Marking and Mapping Section in 1934. In the same year he was made Chief of the Enforcement Section of the Bureau of Air Commerce.

In 1937, Mr. Wynne began the private practice of law in Washington, D.C., and was engaged as legal counsel and aviation adviser to various aviation interests, including Mid-Continent Airlines, Inc., Continental Airlines, Northeast Airlines, and others. He contributed articles to the *Journal of Air Law* and various aviation magazines.

I.A.S.
National Meeting Schedule

Air Transport Meeting—October 24, 1946, Washington, D.C., Hotel Statler.

Tenth Wright Brothers Lecture—December 17, 1946, Washington, D.C., Auditorium of the Chamber of Commerce of the United States.

Fifteenth Annual Meeting—January 28–29–30, 1947, New York, N.Y., Location to be announced.

The Meetings Committee of the Institute invites participation in the technical sessions of the Fifteenth Annual Meeting of the Institute.

Members or organizations wishing to submit papers for this meeting should send complete papers, or outlines or summaries, to the Meetings Committee at least three months prior to the meeting. Outlines or summaries should not exceed 1,000 words.

All papers submitted will be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review*.

All correspondence should be addressed to
The Meetings Committee,
Institute of the Aeronautical Sciences,
2 East 64th Street, New York 21, N.Y.

A New System of Radio Telemetering

DAVID WILLIAM MOORE, JR.*

Fairchild Camera & Instrument Corporation

Introduction

In many instrumentation systems it is desirable or necessary to have an indication of the measured value at some distance from the point of measurement. This is particularly true in aircraft flight testing and in the flying of radio-controlled aircraft. In installations where it is considered advantageous for reasons of safety to remove all personnel from the aircraft being tested or flown by radio control systems, it becomes necessary to have a means for reading the flight instruments in particular, at some remote point. In all such cases, radio is the only practical communication link.

A number of systems have been or are being developed to serve this purpose. These range from telemetering devices producing a graphic indication of the noumenon being studied to systems that faithfully reproduce a dial indication similar or equal to that which would be seen by the pilot if he were present in the plane. Systems of the latter type are particularly desirable in flying radio-controlled aircraft, since they preclude any necessity of having to train an experienced pilot to become familiar with new instruments.

This article describes a telemetering system that permits reading a standard aircraft instrument with only slight modification to the instrument itself, transmitting this reading to any desired remote position or positions, and reproducing faithfully the initial indication on a dial equivalent to that of the aircraft instrument.

Transmitting and Receiving Equipment

When this problem was presented to the Fairchild Camera & Instrument Corporation, all possible means for transmitting intelligence were studied as to their application to this particular installation, which required the transmission of the indication of a standard sensitive altimeter. As a continuous indication was required, all of the step-by-step impulse systems were eliminated. It was also deemed undesirable to employ any amplitude comparison arrangements over a radio link which might seriously affect amplitude values. After much consideration it was decided to use electrical phase angle as the transmission means.

Presented at the Radio and Instruments Session, Fourteenth Annual Meeting, I.A.S., New York, January 29–31, 1946.

* Engineer in Charge.

Fig. 1.

An instrument indication pickup was designed which coupled magnetically to the sweep pointer of the sensitive altimeter, and which shifted the phase of its input signal degree for degree with the motion of the sweep pointer. In other words, for a 90° shift in the position of this pointer, the electrical phase angle of the output signal of the Fairchild pickup would shift 90 electrical degrees with reference to the input signal. The pickup was designed to mount directly on the sensitive altimeter as shown in Fig. 1. No alterations were necessary to the sensitive altimeter other than the mounting of a small permanent magnet on the hub of the sweep pointer. This magnet enabled the use of magnetic coupling to the position pickup and the maintaining of the pressure seal of the instrument.

The position receiving instrument was an electrical phase angle meter with a power output connected to a pointer system similar to that in the original altimeter.

Electronic Components

Schematic wiring diagrams of the electronic components of the position transmission and receiving systems are shown in Figs. 2 and 3.

To transmit intelligence by electrical phase angle, it is necessary to transmit a reference signal to be used as a time or phase standard as well as the intelligence signal. The comparison signal and the intelligence signal are transmitted as two separate audio frequencies on one radio frequency carrier, to permit their being maintained as individual components. Referring to the pickup chassis wiring diagram, VI is a double triode (12 SL 7 GT) acting as a multivibrator oscillator on 250 cycles. This 250-cycle wave then passes through a tuned transformer TR 3 and into one-half of V2 (12 SL 7 GT) acting as an amplifier for the frequency-doubling circuit including V3 (12 H 6), and one-half of V5 which acts as a modulator for the radio transmission system. V3 rectifies the 250-cycle signal, producing a strong second harmonic component which is selected by tuned transformer TR 4 which is tuned to 500 cycles. This second harmonic signal is then fed into the second half of V2, which amplifies it and feeds it into power amplifier V6. This power amplifier energizes the phase-shifting pickup whose output is fed to the modulator V5 and combined with the original 250-cycle signal that is used as the reference signal. The phase angle between the input of the phase-shifting pickup and its output is a function of the position of the altimeter sweep hand.

The output of the modulator tube is fed into a standard radio transmission system capable of being modulated by 250 and 500 cycles and having a small, fixed phase shift between the two signals. For testing, a frequency modulation radio transmission and receiving system was used.

As shown in the wiring diagram for the repeater chassis, the output from the radio receiver energizes two filter systems starting with the first halves of V1 and V2 (12 SL 7 GT's). The output from the first half of V1 is filtered by TR 1 which separates the 500-cycle component energizing the zero setting phase-shifting device, which excites power amplifier V5 (6V6 GT), which, in turn, feeds into phase one of the two-phase motor driving the phase meter indicator.

The first half of V2 is connected to TR 2 which filters out the 250-cycle reference component of the received signal. This 250-cycle component is rectified by V3, producing a strong second harmonic component which is selected by TR 4, producing a reference signal of the same frequency as the intelligence signal, and therefore easily compared with it by a phase angle meter. This 500-cycle component is amplified by V2 and V7 and fed into a phase transformer driven by the two-phase motor. The output of this phase transformer is amplified again by amplifiers V3 and V6 which, in turn, excite phase two of the two-phase meter indicator.

The two-phase motor will develop torque when there is any phase angle difference between the current in phase one and phase two of the motor. Phase one is, as mentioned, excited by the amplified 500-cycle component of the received signal. Phase two is excited by the comparison signal, doubled in frequency and shifted in phase by the phase transformer in the motor-driven phase

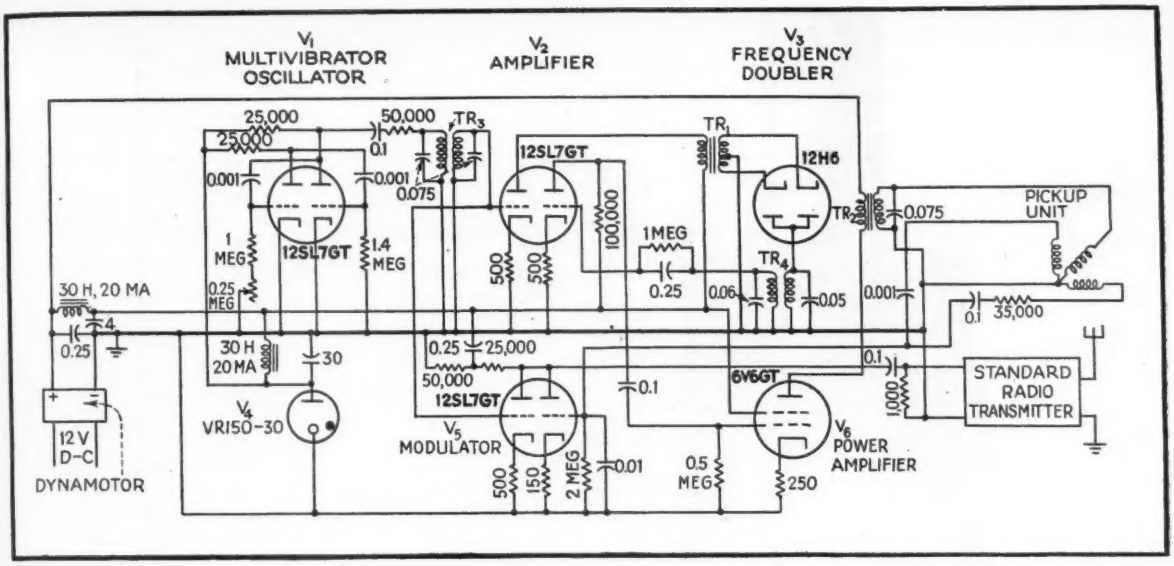


Fig. 2. Schematic diagram of chassis used in plane to convert output of pickup unit into signals that can be handled by one of the plane's standard radio transmitters.

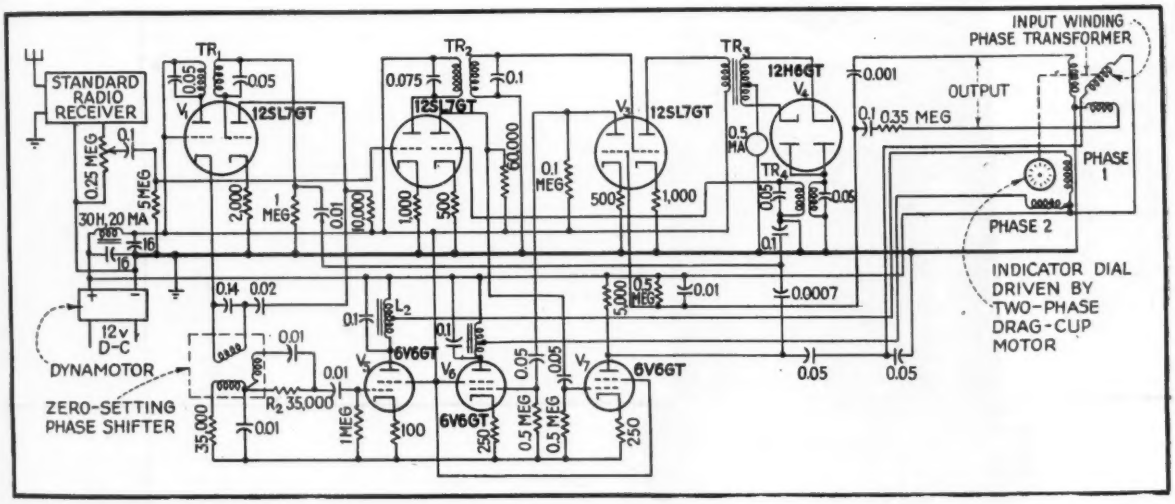


Fig. 3. Schematic diagram of chassis used on ground to convert output signals and receiver into currents suitable for drawing an indicator that repeats accurately the readings of the instrument on the plane.

angle meter. The phase transformer position for zero phase angle between the currents in phase one and phase two of the motor is then a function of the difference in phase between the intelligence and the comparison signal in the received wave, which is, in turn, a function of the altimeter reading. The phase transformer operates the indicating pointer directly. Any discrepancy between the position of this phase transformer and the sensitive altimeter shaft which might be due to electrical phase shifts in the radio transmission equipment and in the transmitting and receiving electronic units, is compensated at the time of installation by adjusting the zero setting phase shifter. This ad-

(*Continued on page 73*)

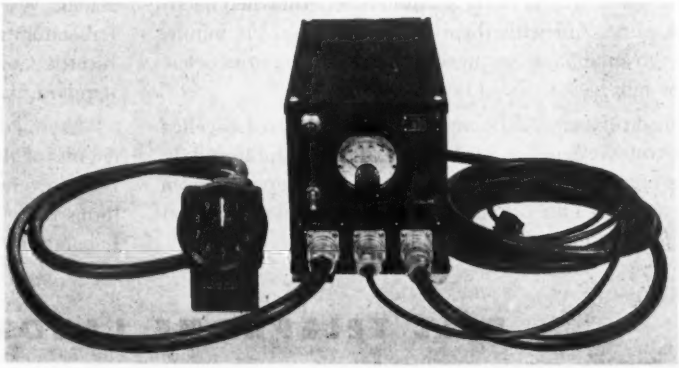


Fig. 4.

Crystal detector–1946 model

Remember the crystal detector in the first radios – hunting for the right spot with a cat's whisker? For years the detector lay discarded in favor of the vacuum tube. But when microwaves came, and with them the need to convert minute energy to amplifiable frequencies, a Bell Laboratories' scientist thought back to the old crystal.

Silicon of controlled composition, he discovered, excelled as a microwave detector. Unlike the old-style natural crystals, it was predictable in performance, stable in service. From 1934 to Pearl Harbor, the Laboratories developed silicon units to serve microwave research wherever needed.

Then Radar arrived. The silicon crystal came into its own, and found application in long-distance microwave Radar. Working with American and British colleagues, the Laboratories rapidly perfected a unit which the Western Electric Company produced in thousands. It became the standard microwave detector.

Crystal detectors are destined to play a big role in electric circuits of the future. They will have an important part in Bell System microwave radio relay systems. In various forms, they may reappear in radio sets. Here again Bell Laboratories' research has furthered the communication art.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED ECONOMIES AND IMPROVEMENTS IN TELEPHONE SERVICE

Aeronautical Reviews

Aerodynamics

Simplified Two-Dimensional Aerofoil Theory. M. J. Brennan and A. C. Stevenson. This paper derives from one of a similar title by H. J. Stewart (JOURNAL OF THE AERONAUTICAL SCIENCES, September, 1942), in which the writer gave an account of a simple method of dealing with thin airfoil theory for small angles of incidence by satisfying the usual approximate condition at the boundary of the airfoil after expanding the slope of the profile in a Fourier series. In the earlier paper it was stated that the inverse problem, the determination of an airfoil shape that will produce a given lift distribution, can be easily solved by the method, but it did not exemplify this by actually finding the thickness of an airfoil. In the present paper the writers actually carry out the solution of a problem envisaged by Stewart's statement and find it necessary to modify his method.

They carry out the complete program in a relatively simple but practical example of Stewart's "inverse problem" in which a complete profile—comprising both camber line and thickness function—is determined from a prescribed pressure distribution. As an example of the effectiveness of the method in a "direct problem," the hinge moment for a flat plate airfoil with flap is found by treating it as a camber line problem. *Aircraft Engineering*, June, 1946, pages 182–186, 194, 10 illus.

Airfoil Development and Structure within the Cambered Surface. Part IX. Roy A. Liming. The ninth section of a serial article deals with the series of problems in the design of a unit such as the typical wing in a manner conforming to prescribed critical aerodynamic specifications, with proper reference to functional design criteria and with regard to convenience and efficiency in tooling and fabrication. Ten critical design factors are set forth which are stated to render imperative a more closely coordinated control of the work of the aerodynamicist, designer, loftsman, and toolmaker than have been afforded by traditional techniques. The essential features of the systematic analytic approach to the aerodynamic definition, design, lofting, and tooling of airfoil assembly developments are summarized as: (1) basic analytic description of wing master lines; (2) definition of a special coordinate system conveniently applicable to the subassembly development; (3) establishment of transformation formulas for conversion of points, lines, and planes, from the basic wing system to the subassembly system, and vice versa; (4) rotation of pertinent wing data into the new system; (5) maintenance of complete and precise, yet simply executed, coordination at all critical points between the two systems. The advantages of such a procedure are outlined in topical form.

Selecting an aileron development as a wing assembly that generally typifies the points emphasized, the writer proceeds to explain the three steps involved in the calculation of the direction cosines of the three wing axes, designated as (1) aileron-hinge centerline; (2) the axis perpendicular to the wing percentage plane in which the aileron lies; and (3) the axis perpendicular to those two axes. By reference to tables in the current installment and in earlier parts of the article, numerical values are assigned to the symbols used in the equations, giving the direction numbers that lead to the establishment of the analytic transformation from the wing to the aileron and back again. The next step is to transform the slope-intercept equations of the basic airfoil percentage lines into the aileron system, according to procedure explained in a previous installment. Calculations determining the upper and lower mold lines of the wing rear spar and the next few percentage planes forward of the spar, together with the percentage elements aft of and including the trailing edge, are sufficient to establish the basic contours of the aileron development. With these equations in the aileron system, rib and hinge contours in planes normal to the aileron-hinge line may be calculated by direct substitution. It is shown that special design configurations, such as balance paddles, leading-edge contours, internal spar structure, attachment fittings, and others may be readily coordinated with the

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

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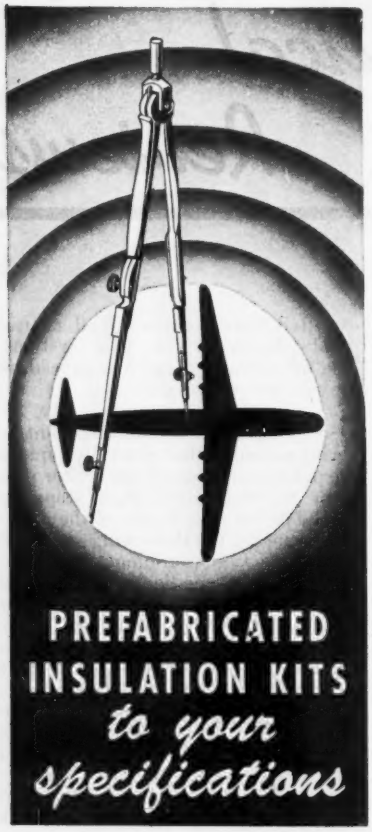

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cambered surface and with the related internal structure by similar analytic control. The hinge fitting attaching the aileron to the wing-spar assembly is taken as a typical example and the solution is worked out. *Aero Digest*, July, 1946, pages 107–109, 4 illus.

Sweepback. James Hay Stevens. It is noted that wing sweepback has been used for years but that recently it has assumed new significance as one of the possible solutions for extremely high-speed flight. The advantages of sweepback are outlined. Difficulties experienced with the use of swept-back wings, one of which is wing-tip stall, which becomes acute at high speeds, are discussed. Methods that have been used to prevent wing-tip stall are described. *Air Reserve Gazette*, July, 1946, pages 6–9, 12 illus.

Velocity Distribution on Wing Sections of Arbitrary Shape in Compressible Potential Flow. Part II: Subsonic Symmetric Adiabatic Flows. Lipman Bers. This paper extends the method of computing the pressure distribution along a symmetric profile of arbitrary shape given in *N.A.C.A. T.N. No. 1006*, under the assumption of a linearized pressure-volume relation to the case of an everywhere subsonic flow satisfying the rigorous adiabatic equation of state. Either the stream Mach Number or the maximum local Mach Number may be prescribed.

The actual applicability of the method depends upon the development of efficient procedures for numerical integration of linear partial differential equations with variable coefficients. Tables and graphs of functions needed for the computation are given, and a velocity correction formula proposed by Garrick and Kaplan is discussed. *National Advisory Committee for Aeronautics, T.N. No. 1012*, June, 1946.

Wind-Tunnel Investigation of Boundary-Layer Control by Suction on the NACA 653-418, $a = 1.0$ Airfoil Section with a 0.29-Airfoil-Chord Double-Slotted Flap. John H. Quinn, Jr. Tests have been made to find the maximum lift of the NACA 653-418, $a = 1.0$ airfoil section equipped with a 0.29-airfoil-chord double slotted flap and a boundary-layer suction slot located at 0.45 airfoil chord. The tests were made at Reynolds Numbers of 1.9, 3.4, and 6.0×10^6 for flap deflections ranging from 0° to 65° and for flow coefficients ranging from 0 to 0.040. The flow coefficient is defined as the ratio of the quantity rate of airflow through the suction slot to the product of the wing area and free-stream velocity.

At a Reynolds Number of 3.4×10^6 a maximum section lift coefficient of 4.16 was obtained with a 65° flap deflection and a flow coefficient of 0.040. With a flap deflection of 0°, a maximum lift coefficient of 2.50 was obtained at the same flow rate. The plain airfoil at a Reynolds Number of 6.0×10^6 had a maximum lift coefficient of 1.50, and the wing with flaps deflected 65° without boundary-layer control at the same

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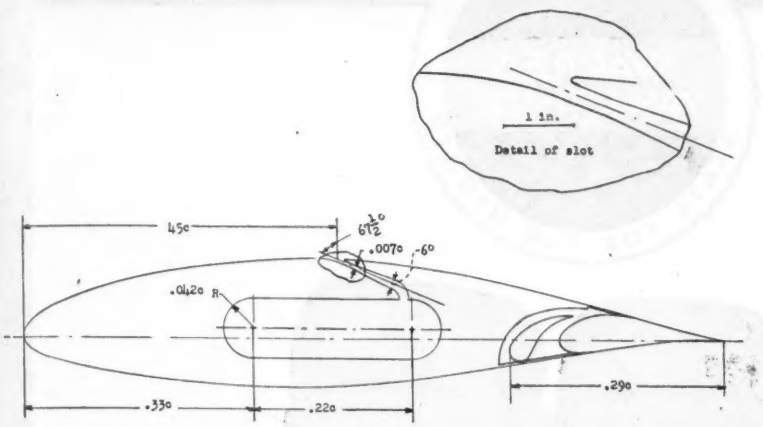


Schematic drawing of N.A.C.A. 65$_3$-418 airfoil section equipped with boundary-layer control by suction and a 0.29c double-slotted flap. (See N.A.C.A. T.N. No. 1071.)

Reynolds Number had a maximum lift coefficient of 3.51. Application of roughness in the form of carborundum particles to the leading edge of the wing decreased the maximum lift coefficient at a Reynolds Number of 1.9×10^6 from 3.88 to 3.16 for a flap deflection of 65° and a flow coefficient of 0.024. Without boundary-layer control, roughness decreased the maximum lift coefficient from 3.11 to 2.84.

At a flap deflection of 65°, Reynolds Number had little effect on the maximum lift attainable with boundary-layer control above a flow coefficient of approximately 0.012 at least at Reynolds Numbers between 1.9×10^6 and 6.0×10^6. Throughout the range of flow rate for which data were obtained, maximum lift coefficient increased with increasing flow coefficient. In no case did the section angle of attack for maximum lift of any of the configurations tested with boundary-layer control exceed by more than 2° or 3° the section angle of attack for maximum lift at a Reynolds Number of 6.0×10^6 for the airfoil with flap retracted and no boundary-layer control. *National Advisory Committee for Aeronautics, T.N. No. 1071,* June, 1946.

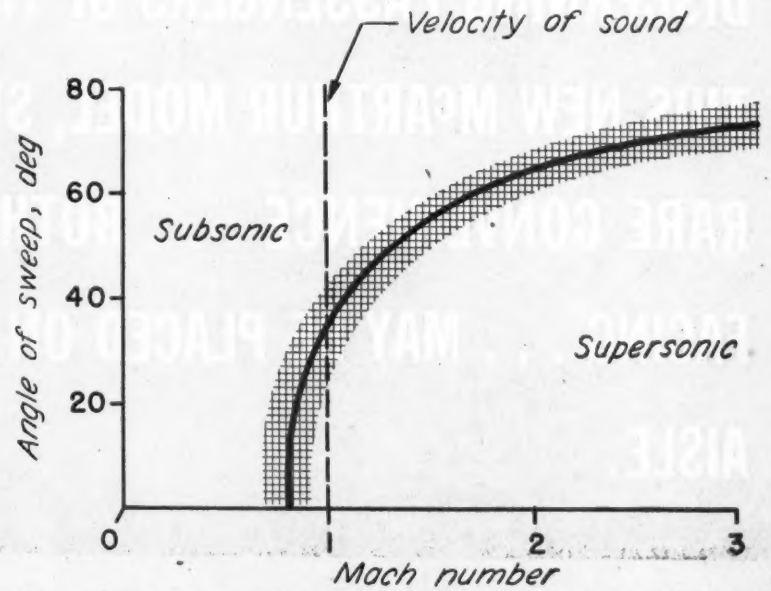
A Simplified Method for Determining from Flight Data the Rate of Change of Yawing-Moment Coefficient with Sideslip. Robert C. Bishop and Harvard Lomax. A method is presented by which the directional-stability derivative, the rate of change of yawing moment coefficient with sideslip angle, can be evaluated for a conventional airplane from flight records of a lateral or directional oscillation. For the method shown, the calculation of the derivative for a particular high-speed flight condition reduces to the determination of only the moment of inertia about the axis perpendicular to the relative air stream, and the period of a sideslipping, yawing, or rolling oscillation.

When applied to conventional airplanes flying at low to moderate lift coefficients, the assumptions involved in this simplified method produce negligible error. A comparison of the directional-stability derivative as determined in flight and in the wind tunnel shows good agreement for the four conventional airplanes considered. *National Advisory Committee for Aeronautics, T.N. No. 1076,* June, 1946.

Influence of Large Amounts of Wing Sweep on Stability and Control Problems of Aircraft. Hartley A. Soulé. The use of large amounts of sweep has been suggested in this country and in Germany as a means of avoiding some of the drag increase and stability and control difficulties encountered in high-speed flight with conventional straight-wing airplanes. Experience with sweep in tailless airplanes and studies made since this suggestion has been made have indicated that the use of a large amount of sweep control will, in itself, introduce stability and control problems of sufficient magnitude and complexity to require considerable research, particularly for flight at high angles of attack. The paper discusses these problems and, although no proved solutions are given, in some cases promising lines for further investigation are presented. *National Advisory Committee for Aeronautics, T.N. No. 1088,* June, 1946.

Langley Full-Scale-Tunnel Investigation of the Fuselage Boundary Layer on a Typical Fighter Airplane with a Single Liquid-Cooled Engine. K. R. Czarnecki and Jerome Pasamanick. An investigation has been made in the Langley full-scale tunnel to determine the thickness and shape of profile of the boundary layer on the fuselage of a typical monoplane fighter airplane with a single liquid-cooled engine. The results showed that, for the range of angles of attack and fuselage stations investigated, the maximum displacement thickness was nearly 1.2 in. and was at the most rearward station (81.6 per cent of the fuselage length). The displacement thickness was found to be greatly affected by the pressure gradients over the windshield-canopy combination and in the wing-fuselage juncture. An average value for the shape parameter (ratio of displacement thickness to momentum thickness) between 1.3 and 1.4 was obtained for the turbulent boundary layer. *National Advisory Committee for Aeronautics, T.N. No. 1087,* June, 1946.

Jet-Boundary and Plan-Form Corrections for Partial-Span Models with Reflection Plane, End Plate, or No End Plate in a Closed Circular Wind Tunnel. James C. Sivells and Owen J. Deters. A method is presented for determining the jet-boundary and plan-form corrections necessary for application to test data for a partial-span model with a reflection plane, an end plate, or no end plate, in a closed circular wind tunnel. Examples are worked out for a partial-



Effect of angle of sweep on critical Mach Number as predicted by simplified theory. (See N.A.C.A. T.N. No. 1088.)

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span model with each of the three end conditions in the Langley 19-ft. pressure tunnel and the corrections are applied to measured values of lift; drag; pitching moment, rolling moment, and yawing moment coefficients. A comparison of the corrected aerodynamic characteristics for all three end conditions indicates that good agreement is obtained with flaps neutral at values of lift coefficient below the stall, and that somewhat less satisfactory agreement is obtained in the region of maximum lift coefficient or with flaps deflected. Except for the corrections to the rolling moment coefficient, the jet-boundary corrections were somewhat smaller for the reflection-plane condition than for either of the other end conditions because the induced upwash angle was the lowest; also, the plan-form corrections for this end condition were considerably smaller because the wing lift distribution was the least altered as compared with that for a complete wing. From every consideration, the use of a reflection plane gave the best results for tests of a partial-span model. *National Advisory Committee for Aeronautics, T.N. No. 1077*, June, 1946.

Pressure Distribution Over a Plug-Type Spoiler-Slot Aileron on a Tapered Wing with Full-Span Slotted Flaps. John G. Lowry and Thomas R. Turner. A pressure-distribution investigation was made in the Langley 7- by 10-ft. tunnel of a plug-type spoiler-slot aileron on a semispan tapered-wing model of a typical fighter airplane equipped with full-span slotted flaps. The purpose of the investigation was to determine the air loads on a designated plug-type aileron described in another N.A.C.A. publication to which reference is made. Tests were made at various angles of attack for both flap-retracted and flap-deflected conditions. In order to obtain more complete data, pressures were measured on a solid plug-type spoiler-slot aileron, of a designated type, at two angles of attack with flap retracted. The results of the investigation indicate peak pressures on a plug-type spoiler-slot aileron that may result in a compressibility shock on the plug aileron at high speed. The maximum loads on the plug aileron occurred in the high-speed condition for maximum up-aileron deflection. *National Advisory Committee for Aeronautics, T.N. No. 1079*, June, 1946.

Effect of Sweepback and Aspect Ratio on Longitudinal Stability Characteristics of Wings at Low Speeds. Joseph A. Shortal and Bernard Maggin. Because of the interest in swept-back wings for high-speed airplanes, an analysis has been made of readily available data on the longitudinal stability characteristics of swept-back wings at low speeds. The analysis indicated that the shape of the pitching-moment curve near the stall for swept-back wings is greatly dependent upon the aspect ratio. A chart has been prepared relating aspect ratio and sweepback which indicates the combinations of aspect ratio and sweepback necessary to obtain stability near the stall for wings alone. The effect of the addition of a horizontal tail behind a swept-back wing may be destabilizing and requires further investigation. *National Advisory Committee for Aeronautics, T.N. No. 1093*, July, 1946.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

The Experimental Determination of the Boundary Layer and Wake Characteristics of a Simple Joukowski Aerofoil, with Particular Reference to the Trailing Edge Region. J. H. Preston and N. E. Sweeting. The work described is a continuation of that described by Batson and Preston in "The Effect of Boundary Layer Thickness on the Normal Force Distribution of Aerofoils, with Particular Reference to Control Problems," *R. & M. No. 2008*, April, 1942. It aims at providing sufficient experimental data relating to the boundary layer and wake in the neighborhood of the trailing edge to enable theoretic work to be undertaken with a view to elucidating the behavior of plain round-nosed controls.

Boundary layer and wake explorations, extending from 50 per cent of the chord ahead of the trailing edge to 75 per cent of the chord behind the trailing edge, have been carried out on a simple Joukowski airfoil at a Reynolds Number of 4.2×10^5 for 0° and 6° incidence using small total head and static tubes. From these traverses the variation of the relationship of momentum thickness, displacement thickness, and other factors to the chord has been obtained over the airfoil and down the wake. The most striking feature is the relatively sudden reduction in the ratios of momentum thickness and displacement thickness to the chord of the wing, on leaving the trailing edge. There is a strong resemblance between the measured variation of these functions in the wake of the airfoil and the calculated variation for laminar flow in the wake of a flat plate, in spite of the turbulent flow in the case of the former.

Traverses have also been made through the boundary layers at the trailing edge for incidences of 0°, 3°, 6°, and 9°, to determine the effect of incidence on the above-mentioned functions and also other features such as the drag, the pressure rise through the boundary layer, and the velocity at the edge of the boundary layer. In addition, the airfoil was pressure-plotted at these incidences for comparison with theory. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1998*. British Information Services, New York, $1.50.

A Note on Supersonic Biplanes. M. J. Lighthill. On a purely linear theory (first order in the disturbances) the results of using biplanes at supersonic speeds are discussed. They have the advantages of structural solidity (important since the wing must be so thin) and low drag. The best shape seems to be the "Busemann biplane," two congruent isosceles triangles pointing at one another. The applicable formulas for the coefficients of lift and drag are set forth.

The writer states that an obvious criticism of the theory of this paper is that it is only a first-order theory. Clearly the second-order theory could be worked out or an exact flow could be worked out graphically by the method of characteristics, but the results would probably not be worth the labor involved. The linear theory holds best in exactly the best conditions for the airfoil (thinness and low incidence), and for other conditions the higher order terms are overbalanced by other errors due to viscosity, inexactness of shape, vibration, etc. Wind-tunnel results indicate that experimental confirmation of terms higher than the first is difficult to find; and it is a frequent theoretic experience that the second-order terms cancel out in the evaluation of lift and drag. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 2002*. British Information Services, New York, $0.45.

Air Transport, General

Civil Aviation in Latin America. William A. M. Burden. "Aviation in South America promises greater development than in any other section of the world," is the general opinion set forth by the Assistant Secretary of Commerce for Air, in an article discussing the Civil Aviation training program in South America; airport construction; Latin America's current position; United States trunk services; European competition; and private flying.

Statistics are given for the route mileage flown in Latin America before the war, showing the relative proportions of United States, European, and resident ownership of the lines. The training program set up by the U.S. Government for Latin Americans in civil aviation techniques is described. The program as a whole has contributed to an appreciation by Latin America of United States aviation techniques and products. Another major contribution to the development of Latin American civil aviation was the airport-construction program carried out for hemisphere defense during 1941–1944. The United States financed the construction or improvement of some 85 airports at a total outlay of several hundred million dollars. Although many of these fields were primarily of military value, a large number of them will be permanently

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In appraising the current position of Latin American air lines, the period between 1935–1941 is cited. During that time private capital remained reluctant to finance air-transport enterprises because of the comparatively low rate of return. However, the expansion of air transport during the war and the introduction of more modern equipment resulted in improved earnings by local air lines and greater participation by the local public in financing such enterprises. A list of prewar air lines in South America is supplied.

It is concluded that United States aircraft manufacturers, as well as air-line companies, will have to face competition from European countries in spite of the improvements of trunk-line services. Most of the light-plane activity is carried out through flying clubs, which as a rule receive a substantial amount of assistance from local governments either in the form of the provision of aircraft, direct subsidies, or both. In summarizing his findings the writer states that a bright future lies before both air transport and private flying in Latin America. *Skyways*, August, 1946, pages 34, 35, 68, 70, 76, 7 illus.

Transport. A report is made of air transportation in the United States, surveying the achievements of the industry one year after the war by comparison with predictions prior to the war. According to the writer, the two factors that enabled the air lines to make greater advances than any other transportation system were (1) the fact that it is still a relatively small business, and the conversion job did not entail the great amount of material, personnel, and work required by the railroads or steamship companies; and (2) the fact that approximately four billion dollars were spent for development during the war. Statistics of the domestic air-transport business list route-miles flown by the 18 domestic air-line operators in the United States and the revenue- and passenger-miles. Comments made by leaders of the aviation industry concerning this postwar first year are cited, and a discussion is presented of nonscheduled air lines. *Flying Age*, August, 1946, pages 29–31, 54, 3 illus.

Comparison of the Great Circle, Airline Route, Highway, and Rail Mileages Between the Fifty Largest Cities in the United States. The material presented in this report was compiled for the purpose of making available to air-freight operators a comparison of the various distances between the 50 largest cities of the United States. The tables list the cities in alphabetical order, with columns showing the mileage to each of the other cities according to the four types of routes. The text contains comments about the competitive modes of transportation and various statistics are given relating to the subject of air transport. *Fairchild Aircraft Division of Fairchild Engine and Airplane Corporation.*

To Study All-Weather Landing Problems. A project devoted exclusively to developing and testing all-weather aircraft landing aids now is being operated by United Air Lines at Arcata, Calif., under a letter of intent from the Navy Department, according to a joint announcement by the Army Air Forces, the Navy, and United Air Lines.

Many factors connected with aircraft landing and field problems under adverse weather conditions will be studied. Included are airfield and approach lighting; fog dispersal, such as the new high-pressure fuel oil burners for dissipating fog; continued use and testing of radio and radar approach systems; supersonic fog-dispersal methods; and basic aerological research. So that all branches of aviation may benefit by the work, United Air Lines will operate the base—officially known as the Landing Aids Experiment Station—in conjunction with a steering committee from the Army, Navy, Civil Aeronautics Board, Civil Aeronautics Administration, Air Transport Association, and the Air Line Pilots' Association. *United Air Lines.*

Air Transport, Cargo

Mechanized Air Cargo Handling. Franklin M. Reck. The problems involved in loading and unloading air cargo and the present methods of meeting these difficulties are discussed. The air lines agree that cargo-handling equipment and methods, in the years of transition, will have to be flexible. Therefore, the air lines are working on various modifications and combinations of the platform, the chute, the belt conveyer, roller conveyer, tractor and trailer, and the high-lift or fork-lift truck. Methods used by several air-line companies are outlined and comments made by them about various phases of the problem are quoted. *Aero Digest*, July, 1946, pages 55, 56, 59, 60, 178, 6 illus.

Air Cargo Potentials Between the United States and U.S.S.R. Another in a series of reports discussing air-cargo potentials between the United States and foreign countries analyzes the potential export and import volume of commodities between the United States and Russia. A study of the commodities that moved between the United States and the U.S.S.R. in 1939 is used as a criterion for the future trend in trade. Four basic factors are considered to be important in determining what should be selected as offering the best prospects for transport by air. They are: (1) value per pound; (2) perishability; (3) fragility; and (4) the style factor, including obsolescence.

Accompanying tables give details of the air-cargo potentials itemized and grouped for convenient reference. Table 1 lists the potential air-cargo trade between the United States and the U.S.S.R. in relation to total trade in 1939. Table 2 records the actual air-cargo shipments between the two countries for specified months of 1944 and 1945. Table 3 summarizes, by value groups, items valued at $0.50 and more per pound, considered to be suitable for air-cargo traffic. Table 4 lists perishables, fragile commodities, and those possessing a style factor. Tables 5 through 8 contain itemized lists of the commodities summarized in Tables 3 and 4, giving their weight, value per pound, and density. *Industrial Reference Service, Vol. 1, No. 8, May, 1946, Department of Commerce, Bureau of Foreign and Domestic Commerce.* For sale by the Superintendent of Documents, Washington, D.C., $0.05.

Air Cargo Hoists. A 4-page illustrated folder describes Herculair air-cargo hoists, which are manufactured in 2-, 4-, and 5-ton sizes, the latter being designed to handle air cargo in flight. A mechanical tripping mechanism automatically locks the brakes when the hoist reaches either end of the craneway. An accelerometer switch automatically locks the brakes and de-energizes the electrical load to the power unit should gust loads on the order of 1.7*g* be encountered while in flight. The specifications of the hoists are listed. *Herculair Products Corporation*, Los Angeles.

Airplane Descriptions

Twin-Engine Lightplane with Centerline Thrust. The fundamental features are reported of a recently developed twin-engined light plane having centerline thrust. The two 80-hp. engines, driving directly connected propellers, are mounted in tandem nacelles behind the passenger cabin, and above the full-cantilever low wing. Each of the horizontally opposed-cylinder type engines is independent of the other, and the propellers face each other in the space between the engines. Since the forward engine drives a pusher propeller and the rear engine a tractor, the propellers are counterrotating with no special gearing required to achieve that effect. Location of the propellers above the center of the wing leaves a clear wing surface and eliminates the danger of injury from the blades to personnel while the engines are idling on the ground or taxiing. Other advantages outlined are unlimited forward vision range, the ease of access through the automobile-type door, the level position of the floor, and the tricycle landing gear that permits take-off and landing at level altitude. A cruising speed of 135 m.p.h., a single-engine cruising speed of slightly over 100 m.p.h., and landing speed of 45 m.p.h. are claimed by the designers. Empty weight is 1,400 lbs. and gross weight is 2,000 lbs. *Southern Flight*, July, 1946, pages 10, 12, 56, 2 illus.

The Chipmunk. E. J. Wilkinson. The de Havilland Chipmunk, a low-wing, all-metal monoplane, using the de Havilland Gipsy Major engine of 140 hp., is described. The current version of this two-seated tandem trainer consists of an all-metal air frame with a stressed-skin covering on most of the surfaces, the exceptions being the control surface and the rear two-thirds of the wing. A side-by-side version also is being designed. The fuselage is of semi-monocoque construction, with a quick-disconnect joint immediately behind the cockpit, dividing the fuselage into two sections. The rear fuselage section is a simple conical shape, having no double curves, and ending in a small bulkhead to which the tail plane, fin post, and tailwheel leg are attached. The fixed landing gear is carried on the cantilever wings, attaching next to the two fuel tanks. Other details are given about the construction of the individual components, and brief specifications are tabulated, showing the dimensions, weights, and performance. The de Havilland Chipmunk is an all-Canadian product from design to manufacture. *Canadian Aviation*, July, 1946, pages 42, 43, 56, 5 illus.; "D.H. Chipmunk," *Flight*, June 20, 1946, page 619, 1 illus.; "The de Havilland Chipmunk," *The Aeroplane*, June 14, 1946, page 692, 2 illus.; "Introducing: The de Havilland Chipmunk," *Aircraft and Airport*, June, 1946, pages 18–20, 53, 7 illus.

Speedy C.A.15 Fighter Built in Australia. Particulars are given about what is stated to be the first wholly Australian-designed combat plane in the over-400 m.p.h. classification. This is the C.A.15, a one-place, long-range escort fighter designed by the Commonwealth Aircraft Corporation, of Melbourne. Powered by a Rolls-Royce Griffon engine, it is said to have a top speed of nearly 500 m.p.h. and is of metal construction throughout. Information is supplied about the air frame, armament, engine mount, landing gear, and other components. *Aviation*, July, 1946, page 89, 2 illus.

The Navarro Naiad. A report is made on a lightweight amphibian project, the Navarro Naiad. The proposal is to fit a small flying boat with short wing stubs, or sponsons, and to house inside them a retractable-wheel landing gear. In addition to the use of sponsons, small wing-tip floats will be employed. The project calls for two Pobjoy Niagara engines producing a combined power of 180 hp. The plane, designed for three occupants, has an estimated gross weight of 3,000 lbs. *Flight*, July 4, 1946, page 22, 2 illus.

Britain's Lightplanes. Compiled by Major Oliver Stewart and Squadron Leader D. West. Fifteen British light planes are pictured and an accompanying table supplies specification data. Nine of the 15 planes listed have been used primarily as military training or liaison aircraft which can be adapted to personal use. These are: the Auster V; de Havilland Tiger Moth; Miles Gemini, Magister, and Messenger; Moss Brothers Mosscraft; Percival Proctor IV and the Trainer; and the Reid & Sigrist Desford. The six planes that were developed primarily as personal planes are the Miles 48; General Aircraft Cygnet; Tipsy Aircraft Tipsy; A. V. Roe Avian, Chilton Monoplane; and Chrislea Ace. A seventh—a personal version of the military Percival Proctor IV, called the Proctor V—is being developed. *Flying*, August, 1946, pages 26–29, 12 illus.

Sokol. A brief article reports specifications of the Mraz M-1 Sokol, or Falcon, and recounts the writer's impressions when flying it. This Czechoslovakian two-place, all-wood, low-wing cabin monoplane is powered by a Walter Minor 4-111 engine with a maximum output of 105 b.hp. and has a top speed of 150 m.p.h. Landing gear retraction is accomplished by means of a large crank between the seats. Flying and landing characteristics are briefly noted. *Flight*, June 20, 1946, page 632, 2 illus.

All-Cargo Transport. The Douglas DC-4-1037 is a new four-engined airplane, specifically designed and built for the transportation of air cargo. Planned to answer the growing demand for fast cargo transportation by air, it will provide a cargo capacity of 22,700 lbs. and a range of 1,500 miles. It is expected to operate at a low cost of 4.9 cents per ton-mile and to fly at a speed of 4 miles per min.

The DC-4-1037 has a 5 ft. 6 in. by 8 ft. cargo door and a cargo capacity volume of 3,691 cu.ft. It has four auxiliary compartments for packaged freight. *Douglas Aircraft Company, Inc.*

Canada's New Four-Engined Aircraft. A new four-engined transport, which has been produced in Canada for the Canadian Government, to be used by Trans-Canada Air Lines and the Department of National Defence, has been test flown at the plant of Canadair Limited at St. Laurent, where it was built. It is a combination of Trans-Canada and Douglas design, with a British-built power plant. Its four engines are a new type of Rolls-Royce Merlin specially designed for air-transport usage. The plane will have a maximum cruising speed of 325 m.p.h., a cruising range of 3,500 miles, and will be able to fly as high as 28,000 ft. It will be used in transatlantic, international, and transcontinental services.

The fundamental difference between the Canadian development and other airplanes built for similar service is in the engines. The Canadian plane will be equipped with British-made Rolls-Royce liquid-cooled engines, Model 620, which will have two stages of supercharging enabling each engine to develop over 1,150 hp. when cruising at an altitude of 23,000 ft. A booklet issued by Rolls-Royce Limited contains detailed descriptions and cutaway drawings of the Merlin 620. *Trans-Canada Air Lines.*

Airplane Design

The Design and Production of Japanese Military Aircraft. Alex P. West. The results of an investigation of the design standards of military aircraft being produced by the Japanese at the end of the late war are reported. The writer was a member of a scientific mission sent to Japan by the Australian Commonwealth Government for this purpose. Attention was concentrated on obtaining information about design trends. The article deals primarily with air-frame design but some information is given about allied subjects, including the value of Japanese research establishments to aircraft designers and the efficiency of the Japanese aircraft industry. The operational and design requirements for Japanese military aircraft are enumerated. Development trends in Japanese aircraft design are described in sections dealing with armament, armor, engines, electrical systems, instruments, the power operation of landing gear and flaps, pressure cabins, primary structures, and other subjects. Consideration is given also to the production of Japanese aircraft, inspection methods, organization and personnel, accident statistics, and test flying. An appendix contains a summary of metallic materials used in Japanese aircraft, together with their chemical composition, recommended heat-treatments and physical properties; and organization charts of a typical Japanese aircraft design department. *The Journal of The Royal Aeronautical Society*, July, 1946, pages 526–549.

ME-163-B—Link to the Future? Arthur V. St. Germain and Richard G. Naugle. A study is made of the German Me 163B, designated as the first successful rocket-propelled military plane. The Me 163B possesses the triple combination of (1) being tailless, and therefore an approach to the pure flying wing; (2) having swept-back wings, which are known to be suitable for entering the supersonic speed range with delayed compressibility effects; and (3) powered by a rocket engine, which allows an unlimited ceiling because it carries its own oxygen with it. The immediate predecessors of this craft were the Delta IV (1935) and the DFS-39 (1936), which differed from the Me 163 in that they had wing-tip rudders instead of a single vertical tail surface. An unusual feature is the use of fixed wing slots over the outer 40 per cent of the wing span, to give antispin characteristics.

A brief history of the origin of the craft, its construction, test flights, and operational activities is given. The plane is said to have reached a Mach Number of approximately 0.85. The bifuel, liquid-cooled HWK 109-509 power plant, weighing 220 lbs. complete, and having a length overall of 7 ft. 2 in. and a height and breadth of about 2 ft.

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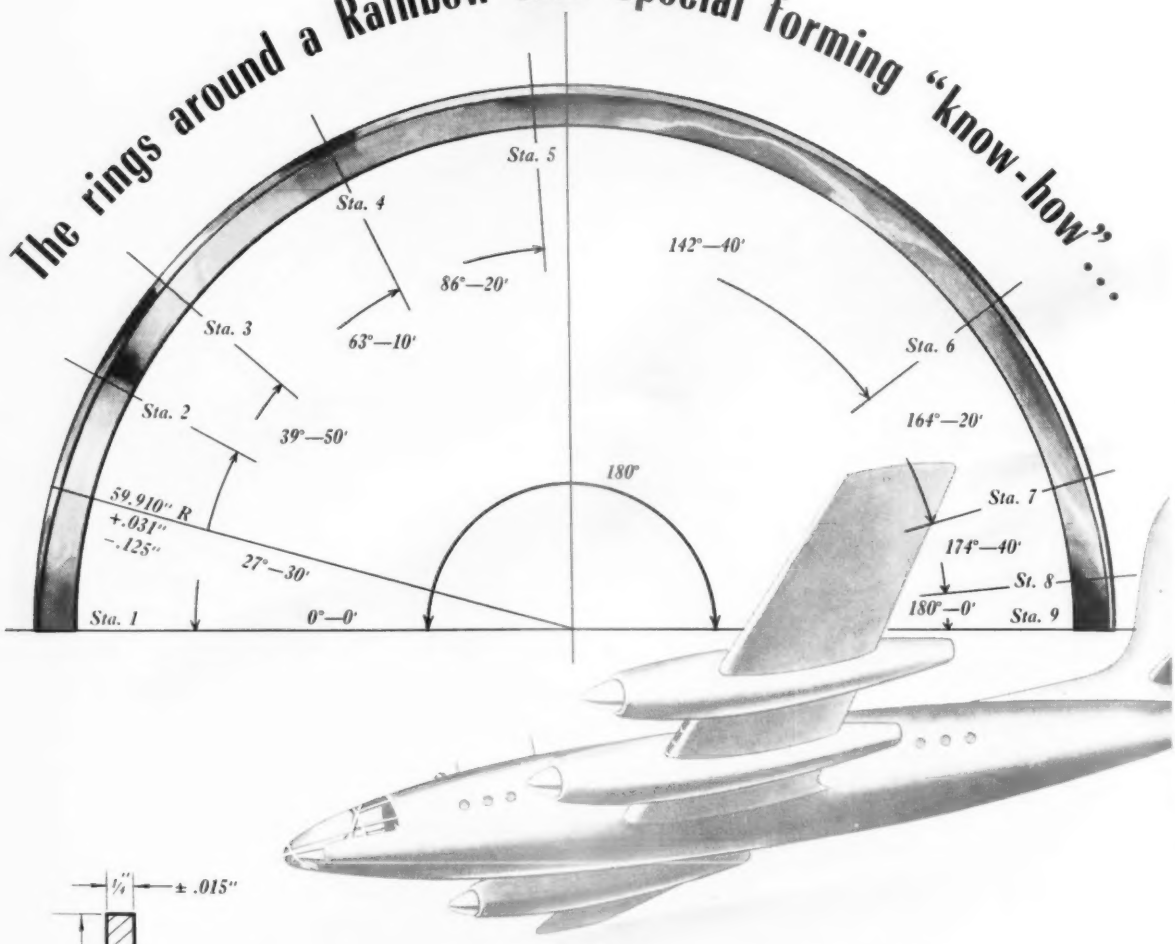

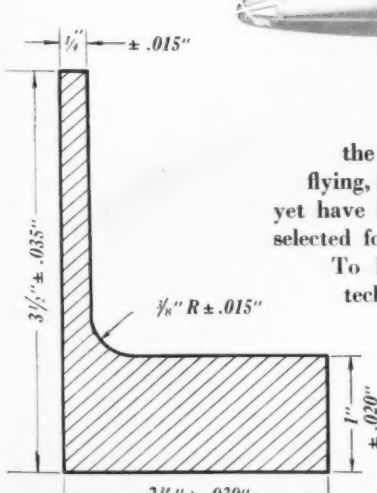

Typical Section Before Machining

The rings or bulkhead caps, together with the bulkheads, carry the wing bending moments of the "Rainbow", Republic Aviations' high flying, fast going, luxury airliner. These caps needed to be of toughest metal, yet have lightest possible weight. Alcoa's alloy 75S, in extrusion form, was selected for this application.

To bend the 19-foot, 75S extrusion, into the form shown, involved techniques uncommon in the aircraft industry. Alcoa's Job Shop lent a helping hand . . . formed and heat-treated the rings, prepared them for final machining.

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6 in., is fabricated as a compact unit, ready for mounting in the fuselage. The so-called "hot-type" rocket engine burns T-fuel (80 per cent hydrogen-peroxide) and C-fuel (hydrazine hydrate and methyl alcohol). The engine and fuel systems are explained in detail.

The writers state that the feature of greatest importance is the rocket engine, and that a conventionally designed plane using the American-developed laminar-flow airfoils would have had equal or superior flight characteristics if powered by the same power plant. It is felt that the Me 163B merely suggests those features known to be desirable for high subsonic or transsonic speeds but which were not sufficiently exploited to the point of securing any great benefits. Highly swept-back wings, of small aspect ratio, used in combination with a submerged power plant and cabin are recommended by the writers as the type of plane for use at speeds approaching the supersonic. *Air Trails*, August, 1946, pages 36–38, 99–104, 5 illus.

Applying Biomechanics to Airplanes. Frederick K. Teichmann. The Chairman of the Department of Aeronautics, Daniel Guggenheim School of Aeronautics, New York University, states that rather than try to adapt the man to the machine, the machine should as far as possible be adapted to the man, which is the objective of the study of biomechanics. Too often the machine has developed so fast that the necessary modifications to make it safer or easier to handle, for example, have had to be done later. Consideration is given to the airplane cockpit as a prolific field for improvement. It is stated that a study of the cockpit should be fundamental in its approach before any thought is given to standardization. Such a study should first be made without regard to existing designs, arrangement, or standardization demands. Studies could be extended to determine what roles the senses of feeling, sight, hearing, taste, and smell play in man's efficiency and reaction under certain conditions. Information that might be obtained by approaching each problem from a fundamental basis is enumerated. *Mechanical Engineering*, July, 1946, pages 628, 629.

Superlift. Squadron Leader Harold J. Payn. Further information concerning the history of the variable-incidence wing follows the article, "Variable Incidence," which appeared in the April 25, 1946, issue of *Flight*. The first experimental aircraft that embodied the Handley Page patented slot device was the Handley Page Hendon, built in 1923. The writer reviews the advantages and disadvantages of the Hendon design, including a condition of increased drag of the fuselage, and the partial screening of the fin and rudder, resulting in a falling off of directional stability and control at slow speed. It is stated that the drag of the highly pitched fuselage seriously minimized realization of the benefit of the fully slotted wing and masked the value of that invention. Reference is made to the 1924 Vickers Vagabond, which is considered a halfway stage in fuselage-wing incidence change.

The application of variable incidence to flying boats is cited by reference to the experience gained in the course of flight trials made on a modified Supermarine Southampton flying boat. The Supermarine 322 is pointed out as an example of the maximum advantage of the full-span slots together with flaps. *Flight*, June 20, 1946, page 625.

Luscombe's New All-Metal Wing. A recent modification to the 65-hp. Luscombe Silvaire is an all-metal wing having but four ribs, two in each panel, and replacing the formerly used fabric-covered wing in which there were 26 metal ribs, 13 to each panel. In addition, the new wing incorporates a single, nonwelded strut replacing the previous V-strut and jury struts. It is described as adding 5 to 8 m.p.h. to the airplane's speed. The new wing consists of a metal shell structure built around front and rear extruded metal spars. The four ribs are located near the juncture of the wing and fuselage. Torsional and drag loads are carried by the wing's stressed skin, which is installed in nine panels, each being replaceable. Because of the absence of internal structure, periodic inspections can be conducted almost entirely from the outside. Only two inspection openings per wing are required, for aileron pulley brackets and the wing-tank gasoline connection, as compared to 13 on each wing in the fabric-covered design. The metal skin, riveted to rolled hat sections, is smooth from root to tip. However, its trailing edge is corrugated, and upper and lower surfaces are riveted together to form the trailing edge. It is reported that production of the airplane is facilitated by the use of the new wing, which has been approved by the C.A.A. *Southern Flight*, July, 1946, page 52, 2 illus.

Make It for Motorists. J. M. Gwinn, Jr. The need for simplified controls in private airplanes is stressed in an article enumerating possible modifications. The writer recommends that future design of the controls be as similar to those of an automobile as possible. *Flying Age*, August, 1946, pages 34, 35, 64, 65, 3 illus.

Engineering Design and Development of the North American NAvion. A booklet describes design features of the North American NAvion four-passenger personal airplane in nontechnical language. Illustrations of important components of the aircraft, manufacturing operations, and testing and manufacturing equipment are included. *North American Aviation, Inc.*

Sweetest Dive Brakes Ever. The unusual dive brakes incorporated in the Martin AM-1 Mauler, a recent design of dive and torpedo bomber for the Navy, are regarded as one of the outstanding features of the airplane. They are composed of intermeshing fingers that fan out in opposite directions when opened and form the flaps when closed, thus performing the dual function of dive brakes and flaps. The alternate rows of fingers are mounted on hinges actuated by hydraulic power, and the entire brake and flap assembly retracts into the trailing edge of the wing. It is stated that the brakes will open in 1 sec. when the plane is on the ground and in 3 sec. in flight at diving speeds around 400 m.p.h., compared with an opening time of 12 sec. for certain earlier types of brakes. Such quick brake action is intended to give the Mauler an advantage in eluding antiaircraft fire and other defensive tactics during both dive bombing and torpedo bombing. It is further reported that the opened fingers require little or no trimming, as in the case of conventional brakes, and that when the brakes open in a dive they produce smooth deceleration, without vibration or jerking. *The Martin Star*, July, 1946, pages 8, 9, 16, 3 illus.

Airports and Airfields

Tests of Flexible Pavement for Airport Runways. Part I. The first in a series of articles discussing flexible pavement for airport runways deals with the testing of structures and loads. The peacetime value of such research work is stressed. Test runways were constructed and subjected to accelerated traffic; numerous existing airfield pavements also were tested. In addition to these service tests, several hundred evaluation reports on satisfactory and inadequate pavements were analyzed. The subjects dealt with are runway structures and test loads; construction methods and machines; construction control tests and test devices; and devices for recording deflection and measuring pressure. An account of the construction and performance of four specific runways is given. The runway construction at Marietta, Ga., is used to illustrate the general technique. The working tests employed most extensively were those for water content, dry density, and bearing ratio. The method of installing deflection gages in couples, one to record surface deflections and others to record base compression, from which the subgrade deflection may be determined, are described. Test figures are tabulated, and sketches show the construction of runway sections. *Engineering News-Record*, July 11, 1946, pages 88–92, 7 illus.

The Blaw-Knox AlumiDoor for Airport Buildings. A folder describes the features of Blaw-Knox aluminum doors for airport buildings. Dual unit operating mechanisms are installed on the upper corners of the doors. It is stated that the light weight of the door reduces the size of the truss or girder needed in the structure. *Blaw-Knox Division of Blaw-Knox Company*, Pittsburgh.

Maintenance Hints for Airport Lighting. Information that will aid airport operators in the maintenance of lighting systems is presented in a 24-page booklet. Sections are devoted to inspection, the cleaning of equipment, the renewal of lamps, and the special attention that should be given to each type of equipment. *Westinghouse Electric Corporation, Lighting Division.*

Avigation

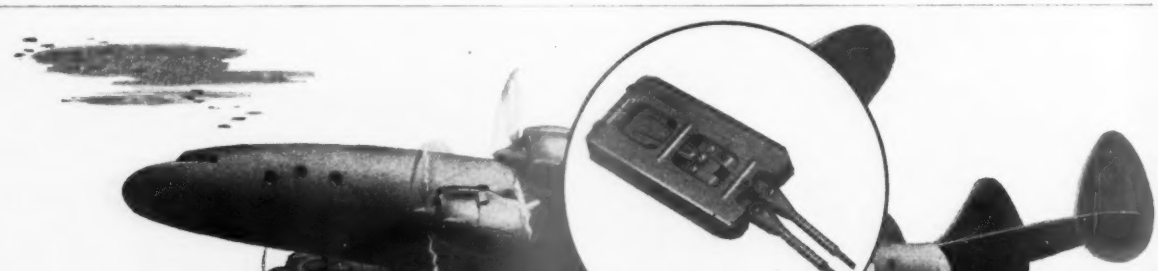
Instrumental Solutions in Celestial Navigation. Samuel Herrick. A survey is presented of a selection of mechanical devices designed for reducing astronomical observations, made with a sextant or octant, to lines of position on the surface of the earth. The devices discussed are classified according to: (1) devices that give altitude and azimuth; (2) devices that give position; (3) devices that combine observation and reduction; and (4) the need for increased accuracy. The various methods for reducing astronomical observations may be divided into three systems: tabular, graphic, and instrumental. Methods employing instruments are defined. The theory and operation of the Hagner position finder for finding altitude and azimuth are described. A similar five-arc measuring instrument devised by E. J. Willis also is treated. Inasmuch as instruments providing only altitude and azimuth suffer from a common limitation, they leave to the navigator the work of plotting azimuth and altitude-intercept. In this respect a device that supplies position is more desirable. The spherographical system of D. A. McMillen is a device supplying position and makes use of a precision-shaped sphere and auxiliary spherical scales or rulers, compass, and protractor. The latitudes and longitudes of at least two substellar points are plotted on the sphere by means of the scales; the circles of position are described by the compass set for the observed altitudes; and the latitude and longitude of the intersection or fix are read by means of the scales initially used.

It is stated that the first celestial navigation instrument to combine reduction with observation, other than sun compasses or other devices not accurate enough for position determination, was probably the Kaster "spherant." This instrument, adapted from the astronomical coudé telescope, is explained in detail. The writer states that with portable instruments the error (exclusive of the observational error) should not be expected to be less than 2 or 3 min. *Navigation*, June, 1946, pages 22–27, 4 illus.

Navigating by Altimeter. Part II. Lt. Herbert F. Langdon. The principles involved in navigating by altimeter were explained in the first installment of this series which appeared in the May issue of *Air Transport*. In the concluding installment altimetry navigation in practice is studied. The procedure used in determining drift is outlined in ten steps, and a typical set of readings is applied to the formula and tables, both of which were supplied in Part I. The results of tests made over a period of 6 months showed that this method of navigation is capable of accumulating an average error, in the calculation of drift, of only 0.6°. In percentage error for a given distance this amounts to 1.05 per cent or approximately 20 miles on a 2,000-mile flight. It is concluded that track is the most reliable information to be obtained from this system of navigation. Ground speed may not be so accurately determined. Hence, a combination of altimetry and celestial navigation is advised. *Air Transport*, July, 1946, pages 47, 49, 3 illus.; "Aerologation," by Edward T. Bolton, *Navigation*, June, 1946, pages 27–31, 2 illus.; "Aerologation," by Robert Mansfield, *Air Sea Rescue Bulletin*, NAVCG 128, U.S. Coast Guard, June, 1946, pages 9–17, 52, 13 illus.

Accuracy of Position Finding Using Three or Four Lines of Position. S. A. Goudsmit. The theory of interpreting celestial lines of position for both three- and four-star fixes is explained. It is concluded that if a location is determined by the intersection of three lines of position, there is a probability of only one in every four instances that the true position lies inside the residual triangle. If the location is determined by the intersection of four lines or position, the probability that the true location lies inside the larger quadrangle formed by the four lines is increased to 50 per cent. *Navigation*, June, 1946, pages 34, 35.

Interpretation of the Celestial Line of Position. Austin Phelps. The various possible factors in celestial observation error and the resulting lines of position are enumerated. The basis for interpretation in each instance is analyzed. The sources of error in sextant observations, taken from a moving aircraft, are divided into two groups:



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(1) random errors caused by bubble acceleration, and (2) constant errors caused by unknown sextant error, dome refraction, or personal error.

A test consisting of a series of carefully controlled observations was conducted to determine the average accuracy of the celestial line of position obtained from an aircraft in flight. Eighty-three observations were made by seven Army navigators. The average error for all the observations was 6.6 nautical miles. The conclusion drawn from this experiment was that random errors in sextant observations are so much more frequent than the constant errors, that the assumption that the most probable position of a three-star fix will fall outside the triangle is unwarranted. *Navigation*, June, 1946, pages 32, 33.

Long Range Navigation. Comdr. W. F. Catlee and Lt. Comdr. C. A. Coutts. The writers have attempted in this article to integrate a few of the many aids available and the systems now in existence for air navigation, and to show how they may be intelligently used for long-range operations. A plan is set forth for a typical long-range flight in which the following methods of navigation are employed: dead reckoning; radio; loran; celestial; aerologation; and radar. The study is divided into the following sections: the problem; preflight considerations; analysis of weather; selection of charts; choice of celestial and radio tables; selection of route; analysis of navigation aids to be used; preparation of flight plan; preparation of fuel analysis and preliminary "Howgozit" curve; in-flight navigation; postflight analysis; training requirements; and the choice of a sample problem. A preflight check list for the navigator is reproduced. *Air Sea Rescue Bulletin*, NAVCG 128, U.S. Coast Guard, June, 1946, pages 24–33, 8 illus.

Electronic Navigational Aids (Loran, Radar, Racon). A pamphlet of 48 pages is prepared in nontechnical language for the information of the U.S. maritime industry and commercial air lines interested in the application of electronic navigational aids. The pamphlet was prepared largely to answer inquiries received by the Coast Guard on those subjects.

The first section traces the historical background of loran, the second gives an extensive description of the system, the third deals with applications of the system, and the fourth section outlines the technical aspects. *United States Coast Guard, Public Information Division*, Washington, D.C.

Business and Finance

The Future of Commercial Aviation. James H. Doolittle. The Vice-President of Shell Union Oil Corporation gives an estimate of the potential market for commercial aviation. Citing figures based on studies made by the C.A.A. and other organizations, he indicates that by 1955 there will be 400,000 or more registered civil aircraft in the United States, necessitating an industry with a dollar volume in excess of $2,200,000,000 and providing employment for more than 900,000 persons, of whom approximately 50 per cent will be engaged in the manufacture of aircraft. A large part of the revenue also will come from that source. Before discussing the various forms of civil aviation that will make possible such volume and employment figures, the wartime commander of the Eighth Air Force emphasizes the urgency of keeping the aircraft industry in the prime of productive health. To maintain the nation's leading position in air power, purchases by the armed forces of a minimum of 3,000 new combat airplanes at a cost of $750,000,000 annually are needed. Next to aircraft manufacturing, the domestic air-transport industry is expected to reach a traffic volume of about 11½ billion passenger-miles by 1955, with annual revenues of $345,000,000, and over 100,000 employees. International air-transport volume is estimated at approximately 2,000,000 passengers per year to foreign ports by 1955, providing work for more than 35,000 persons. In an analysis of his estimate of the total number of aircraft in use, the writer forecasts that about 280,000 will be for personal business and recreation, 40,000 for corporation business use, and 80,000 in commercial service. He gives traffic figures and reviews the varied activities in which aircraft can be used, as well as the need for more airports and other facilities for handling air traffic. *The Pegasus*, July, 1946, pages 10–13, 16, 1 illus.

With fingers unmeshed as illustrated, the dive brakes of the Martin AM-1 Mauler are in position to slow down the airplane during a dive.

Control Systems

Messier Hydraulics. A survey of the high-pressure hydraulic system installed in the Handley Page Hermes and the Hastings is presented in an article describing a combination of hydraulic and electric power systems. The hydraulic system used on the Hermes and Hastings is a slightly modified version of that employed on the Halifax. The electrohydraulic elements of the system are contained in the flap-operating circuit. Flaps are actuated by a single jack, a mechanical linkage insuring synchronization. They are raised by main circuit pump delivery but are lowered by the energy stored in the separate flap-system accumulator. The linkage and accumulator inflation pressure are designed so that should a predetermined speed be exceeded the flaps will close and no mechanical damage will ensue. Details of the system are explained and the three-position control unit is diagrammed. Inasmuch as the installation is a high-pressure system, an electric booster pump is fitted to the reservoir tank, "supercharging" the suction line to each engine-driven pump so that cavitation does not occur at high altitudes. A description and diagram explain the emergency air system for operating the landing gear, and the retraction geometry for the main landing gear and the tailwheel is shown in diagrams. *Flight*, June 27, 1946, pages 653–655, 10 illus.

"Packaged" Automatic Pilot. Originally developed for fighter aircraft through the cooperation of the Control Equipment Branch of Air Matériel Command, the Lear C-2 Fatigue Relief Pilot is equally capable of operating heavier aircraft. Being electric, it is easily interconnected with other control devices, such as those used for altitude control, instrument landing, and radio homing. It operates from a 24–28-volt system.

The Lear C-2 requires only three working units: a controller, located on or near the instrument panel; a control unit or amplifier, which contains both the vertical and directional gyroscopes; and a triple-output friction drive servo unit directly controlling the cables operating the airplane's ailerons, rudder, and elevators. A feature of this installation is that no "plumbing," bleeding of lines, or adjustment of follow-up mechanism is required. The three units are simply bolted in place and plugged into the electric power source of the airplane. *Lear, Inc.*, Grand Rapids, Mich.

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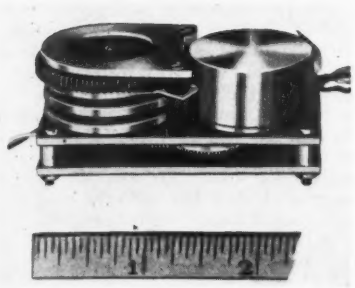


Lear two-phase, 500-cycle a.c. drag cup motor. The motor is shown on the right and the pick-off sensing device on the left.

Small Motor Used in New Automatic Flight Control System. The Lear Drag Cup Motor, Model GZ is designed to maintain continual alignment, to synchronize the circuits for the immediate engagement of the Lear L-201 Automatic Flight Control, and to hold the pitch axis input signal at "null" at all times prior to the engagement. With a mechanical power output of 7.4 milliwatts, or only ninety-nine one-millionths of one horsepower, the small two-phase 500 cycle a.c. motor produces torque at approximately 0.002 oz.-in. at 5,000 r.p.m., and adds less than 0.05 lb. to the overall installation weight of 30 lbs. of the control system.

Circuits of the Lear L-201 Automatic Flight Control System are continually aligned and synchronized by rotating the Learsyn, a pick-off sensing device producing signal voltage which develops the error signal and causes the amplifier channel to operate the system. The device eliminates the necessity for manual synchronization prior to engagement of the control system. *Lear, Inc.*, Grand Rapids, Mich.

Education and Training

Machine Design Textbooks Should Contain What Name Implies. Zola Fox. Means of improving textbooks on machine design are suggested. It is urged that more emphasis be placed on "good practice" and what is now called "Detail Design." Examples of what is meant by detailed information are given. It is also suggested that the reader be advised on the choice of one or more methods of designing a part, with poor, good, and preferred designs indicated. The incorporation of more detailed information about important materials also is urged. The writer believes that chapters on sheet-metal practice should be included in machine design textbooks, that chapters on welding should include information about brazing and spot welding, and that descriptions of overall machine and component failures should be given. *Product Engineering*, July, 1946, pages 124–127, 5 illus.

Electronic Flight Trainer. The Curtiss-Wright Dehmel electronic flight trainer with automatic radio range embodies a full aircraft instrument system, as well as an automatic four-course A-N radio range, two-course visual-audible V.H.F. radio range, and blind-landing system. One prototype of the electronic flight trainer represents a twin-engined fighter-type airplane similar to the P-38. The current model simulates the flight characteristics of an AT-6 airplane, although the instrument panel and cockpit arrangement have been modified for training purposes.

When the controls are operated, all the interacting effects of lift, drag, thrust, and the various moments and other forces causing the airplane to maneuver, stall, or spin in space are developed as electrical voltages. These voltages are sent as signals to the computing system of the trainer, which derives the correct answers promptly as voltages or shaft rotations which represent such functions as air speed, rate of climb and turn, pitch, and roll. These answers are continuously translated into meter indications within the cockpit of the trainer.

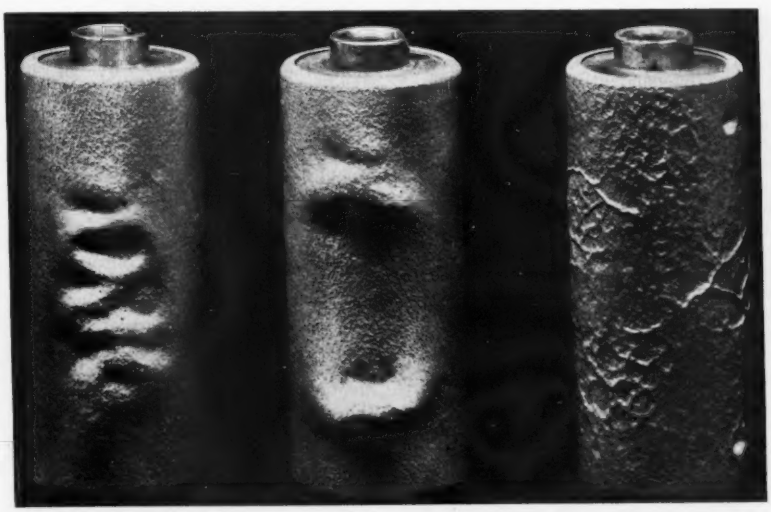
The complete apparatus of the electronic flight trainer is contained in one compact metal assembly, and no auxiliary tables or other equipment are required. The floor space needed is 3 ft. 4 in. by 8 ft. 10 in., and the total maximum power consumption is 15 amp. at 115 volts. It is stated that the equipment requires very little maintenance. *Curtiss-Wright Corporation.*

Engine Parts and Accessories

Bond Testing of Silver-Plated Engine Bearings. Frank D. Hallworth. Nondestructive methods of bond testing silver-plated bearings for aircraft engines are described and evaluated. The article has particular reference to the experience of the Pratt & Whitney Engine Division of the United Aircraft Corporation. Consideration is given to methods used for testing finished parts, which include the supersonic pulse method, fluorescent penetrant oil method, and the whirl test, and to those that can be used only on semifinished parts, which include the shear test, roll-peen test, and the shot-peen test. Other testing methods that have been tried with little success also are mentioned. It is concluded that the choice of methods used for bond testing a given part depends upon its shape, its size, and the thickness and location of the plate. Cylindric parts with thin plates lend themselves best to roll testing. Pratt & Whitney Aircraft practice is to shear test parts having thicker plates, followed by either a whirl test or a peen test. The latter test, however, is replacing the whirl test because of its adaptability to any size and shape of part. In addition, peen-testing equipment is more economical to maintain and its production rate is higher. *Automotive and Aviation Industries*, July 15, 1946, pages 30–33, 64, 66, 68, 11 illus.

Comparative Effectiveness of a Convection-Type and a Radiation-Type Cooling Cap on a Turbosupercharger. Frederick J. Hartwig, Jr. An investigation was made to compare the effectiveness of two basic methods of cooling a turbosupercharger and to obtain data on the temperature level and distribution in the turbine wheel. Turbine-wheel temperatures were obtained for various conditions of cooling-air mass flow, exhaust-gas temperature, and exhaust-gas mass flow. Modified forms of the standard cooling caps were used to allow for the installation of temperature-measuring devices.

The convection-type cap that employs a jet of air blowing on the rim of the wheel gave temperature reductions of the order of 150°F. when the airflow was increased from 0 to 3 lbs. per min. (average flow for a flight installation), and further temperature reductions were attained with increased airflow. With the radiation-type cap, in which the cooling air never comes in contact with the turbine wheel, maximum reductions in wheel temperature of 20° to 30°F. were attained with airflows up to 3 lbs. per min., and no additional cooling



Shot peen tested articulated rod pins with defectively bonded silver plate. (See "Bond Testing of Silver-Plated Engine Bearings.")

was obtained with greater flows. *National Advisory Committee for Aeronautics, T.N. No. 1082,* June, 1946.

Turbosupercharger for Stratocruiser. It is announced that the Boeing Stratocruiser will be equipped with modified General Electric turbosuperchargers that will make it possible to save up to a maximum of 14 per cent in fuel consumption at cruising altitudes. In addition to supercharging the four Pratt & Whitney engines, the turbosupercharger will provide air for the cabin altitude-conditioning system. This modified installation, designated as BH-4, is both smaller and lighter in weight than the conventional maximum-horsepower type. It is designed to supercharge the engine at cruising powers only and is not needed during take-off. *Boeing Aircraft Company.*

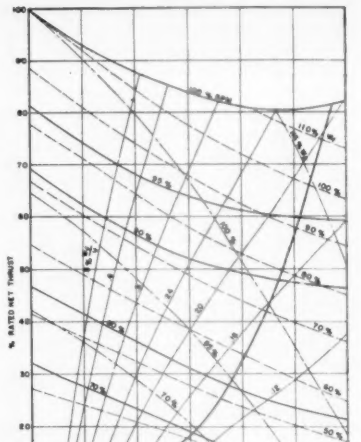
Engines, General

Comparison of Propeller and Reaction-Propelled Airplane Performances. Benson Hamlin and F. Spenceley. The purpose of the paper is to evaluate the airplane-performance potentialities of four types of widely differing power plants and to indicate their trends and particular fields of application. Four power plants having distinctly different performance characteristics have been chosen: (1) a V-type, reciprocating, liquid-cooled engine employing water injection for emergency power; (2) a turbojet engine having about 23 per cent less sea-level static thrust than the former; (3) a hypothetic subsonic ram-jet; and (4) a bipropellant liquid-fuel rocket motor. For brevity, these power plants are referred to as propeller, turbojet, ram-jet, and rocket, respectively. Because these power plants differ so radically in performance characteristics, it is difficult to determine a sound basis for comparison. It was therefore decided to design a single-engined, single-place fighter or pursuit-type airplane employing each type of power plant and limiting the size to some reasonable weight, assumed to be less than 14,000 lbs.

The text is divided into three parts. Part A compares the various types of engines independently of airplane characteristics insofar as possible. Part B briefly describes a logical and practicable airplane-design configuration for each power plant. In Part C the results of the airplane-performance characteristics are presented, from which comparisons and conclusions may be advanced. The conclusions are summarized under the four main classifications, setting forth the applications for which each type of power plant is suitable and the limitations of each. *Journal of the Aeronautical Sciences,* August, 1946, pages 425–437, 17 illus.

Engines, Gas Turbine

Jet Propulsion and Its Application to High-Speed Aircraft. D. J. Keirn and D. R. Shoults. The writers limit their consideration to jet propulsion apparatus using the same atmospheric



Composite chart relating true air speed, per cent rated thrust, per cent fuel flow, per cent airflow, and fuel flow per mile for a typical jet engine for standard atmospheric sea-level conditions, 85 per cent ram efficiency. Superimposed is the drag polar of a typical high-speed jet-propelled airplane. (See "Jet Propulsion and Its Application to High-Speed Aircraft.")

air for propulsion as for the thermal cycle and in which the gas-turbine driven compressor supplies the major component of the pressure for the thermodynamic cycle. They review briefly the early development of the aircraft gas turbine, including the Whittle unit, the creation of the General Electric jet power plant, and the design of the XP-59 jet fighter by Bell Aircraft Corporation. The principles of jet propulsion are set forth concisely, with the mathematical expressions for calculating the performance of the components of the power unit. The operation of the unit is explained, as well as methods for computing its performance.

Possible future improvements are forecast with regard to fuel consumption, thermal efficiency, overall efficiency, and advances in turbojet powerplant design. Consideration is given also to possibilities of augmenting the thrust by means of inducing an additional flow of air through the propelling nozzle; by utilizing the pumping action of the high-speed jet for boundary-layer control, to increase the lift and shorten the take-off run; and by burning additional fuel in the gas stream between the turbine and the propelling nozzle. In conclusion, the writers survey the prospects for larger power plants and discuss the influence of the use of the turbojet engine upon the problems involved in the design of the airplane. *Journal of the Aeronautical Sciences,* August, 1946, pages 411–424, 17 illus.

Lectures on the Development of the Internal Combustion Turbine. The entire issue under review is devoted to a series of special lectures on the development of gas turbines, as follows:

The Development of the Internal Combustion Turbine, by Hayne Constant. To indicate the scope and significance of the lectures, the general historical background of the development of the gas turbine in Great Britain is briefly reviewed. It is explained that the purpose of the lectures is to place before the engineering world an account of the basic work that has been done on the problems of the gas-turbine engine.

The Early History of the Axial Type of Gas Turbine Engine, by Hayne Constant. The writer discloses how the outlook of those responsible for directing early researches in Great Britain on the axial type of gas-turbine engine developed as the work proceeded. He explains the reasoning behind each technical step that was taken and then shows how subsequent developments proved or disproved the validity of the reasoning.

The Design and Development of Centrifugal Compressors for Aircraft Gas Turbines, by L. J. Cheshire. This paper deals exclusively with the centrifugal compressor development, but in the introduction the relationship between this unit and the remainder of the engine is explained. It is noted that apart from the combustion problem, which was virtually solved before the first flight, the more intractable development troubles with the Whittle engine were almost wholly concerned with the compressor. A large part of the paper is devoted to the aerodynamic and mechanical problems special to the aircraft gas turbine.

Fluid Dynamics of Axial Compressors, by A. R. Howell. A simple fluid dynamic theory is developed for the flow through the cascades of blades which make up an axial-flow compressor. The theory is based on a knowledge of the wind tunnel, or two-dimensional flow past cascades, coupled with the correction factors required to give the actual mean stage conditions in the compressor. Particular emphasis is given to the incompressible or low-speed stage characteristics that form the background of performance calculations. Data are included to enable these to be worked out.

Design of Axial Compressors, by A. R. Howell. How basic information about the fluid dynamics side of axial compressor design is used is explained. The writer also describes the use of simplified methods in deciding on the best layout; the detailed design of the arrangement decided on; and the final checking of the design by means of a performance estimation.

Combustion in the Gas Turbine, by Peter Lloyd. Problems connected with the combustion processes in aircraft gas turbines are discussed. It is stated that in spite of the technical effort devoted to it, the combustion process was for a time the limiting factor in the development of both centrifugal and axial-flow turbines. The main requirements for the combustion system are enumerated. Research work directed toward the fulfillment of these requirements is described. The essentials of the combustion technique that has evolved in the last 5 years are summarized.

Technique of Testing Gas Turbine Engines, by D. N. Walker. The history of the testing of gas turbines is outlined and the importance of turbine engine testing is explained. The problem of obtaining accurate measurements is discussed. Other sections deal with test-house design, component testing, special tests, and the standard acceptance test. A few remarks on American and German testing are included.

Some Vibration Problems in Gas Turbine Engines, by R. G. Vosey. Gas-turbine vibration problems and their solution are treated. Sections are devoted to the history of vibration troubles with the centrifugal impeller; the examination and classification of modes; the excitation of impeller modes in the engine; the evolution of the method of estimating fundamental frequencies; and decoupling vibration in the vane tip. Other sections discuss crack detection by vibration methods; vibration troubles on turbine blades; the failure of plastic compressor blades; the importance of internal damping capacity; and fatigue failures of combustion components.

The Turbine for the Simple Jet Propulsion Engine, by J. Reeman. An account is given of the methods adopted and the problems encountered in the design of a turbine for the simple jet engine. Aerodynamic design requirements are discussed and consideration is given to the duties of the turbine and the method of design.

Recent Developments in Materials for Gas Turbines, by T. A. Taylor. The writer gives an account of material problems that have been encountered since 1939 in the development of the gas-turbine engine, and of the materials that have been used in an attempt to overcome these problems. Sections deal with turbine blades, discs, nozzles, combustion chambers, and compressors. New methods of testing materials are described. *Proceedings of the Institution of Mechanical Engineers*, Vol. 153, 1945, War Emergency Issue No. 12.

Factors Affecting the Design of Jet Turbines. William R. Hawthorne. Reference is made to how the advent of the gas turbine has changed the character of the aircraft-engine designers' problems. It is stated that the aircraft-engine designers of the future will be preoccupied less with problems of mechanical design and more with those of fluid motion. With the gas turbine, experience has shown the value of the analytic approach in the design stage, in predicting possible troubles and in the interpretation of test results. To illustrate the analytic approach, the writer reviews the problems of designing a jet turbine with a centrifugal compressor, most emphasis being laid on the aerodynamic and stress limitations. An analysis of factors affecting the thrust output of the Whittle jet turbine shows that the design is a compromise between aerodynamic and stress problems. It is concluded that in making the conversion from the piston engine to the gas turbine, the design office will have to provide itself with some new equipment and the major item will be a fund of aerodynamic knowledge. *SAE Journal*, July, 1946, pages 347–357 (Transactions), 16 illus.

Jets on Test. A detailed description of the production-testing of plain jet power units is supplied, with sketches and diagrams of the equipment used. It is stated that production-testing of plain jet power units does not present the same difficulty as the testing of high-powered piston engines, and the whole process of installation and thrust measurement can be accomplished in a comparatively simple and straightforward manner. The time required to install a Goblin for test is only 2 hours and removal from the test bed takes no more than $1\frac{1}{2}$ hours. A description is given of the test procedure employed at Hatfield. Thrust is measured directly through the reaction of the unit or mounting against a statimeter transmitter button. When the unit is running, temperatures, pressures, and consumption rates are observed and recorded in a soundproofed control room.

A detailed outline of the test schedule designed for the Goblin engines is supplied. On completion of the preliminary tests, the engine is disassembled, inspected, and rebuilt. It then goes through a final test. A more complex method used for testing propeller turbines is mentioned. *Flight*, June 27, 1946, pages 648a–648d, 7 illus.

Gas Turbine Developments. Part I. The first part of a serial article about developments in the field of gas-turbine design and manufacture deals with the combustion research laboratories of Joseph Lucas, Ltd. Information is given about the organization of the laboratories and the layout and equipment. Some of the combustion problems attacked at the laboratories required aerodynamic, thermodynamic, and mechanical investigations, of which an outline is given. *The Engineer*, July 5, 1946, pages 2–5, 9 illus.

The Evolution of Energy in Jet and Rocket Propulsion. P. Bielkowicz. In a continuation of an article on jet and rocket propulsion, the writer discusses a method of determining the temperature in the combustion chamber which is stated to be more accurate than one described in a previous installment. Simplified schemes that provide a means of attacking the problem are enumerated. In order to simplify the problem, a number of far-reaching assumptions are made. It is noted that the method presented is rather laborious but that certain simpler graphical methods apply only to combustion at atmospheric pressure and cannot be used for gas-turbine temperature calculations. *Aircraft Engineering*, June, 1946, pages 206–208, 4 illus.

Meteor Climatic Trials. The results of a series of climatic tests on the Meteor jet engine, conducted with standard Gloster Meteor III aircraft, are briefly described. The first trials were for tropical conditions and took place at Khartoum. Ground temperatures averaging 25°C. and a simulated sandstorm were the prevailing conditions. The effect on the compressors and turbine blading was said to be negligible. On the basis of these tests, it is stated that the Meteor is the first jet-propelled aircraft to be cleared for operation in desert conditions. Trials for Arctic conditions were conducted at Edmonton, Alberta, where ground temperatures averaged −35°C. The only troubles experienced were connected with synthetic rubber sealing glands, which tended to become brittle and to leak. The aircraft had only standard equipment and no special precautionary devices were used. *Flight*, June 13, 1946, page 599, 4 illus.

Engines, Reciprocating

New Engine. Details are set forth about a recently developed six-cylinder, horizontally opposed air-cooled engine with sliding sleeve valves, manufactured by Jack & Heintz Precision Industries, Inc. Both aircraft and automotive versions of the engine will be produced in two-, four-, and six-cylinder models. Die-cast light alloys are used extensively in the construction. The engine incorporates many novel features which are described. The banks of cylinders and half crankcases are bolted together on the centerline of the crankshaft. The complete crankshaft assembly consists of the crankshaft, main bearings, connecting rods, pistons, and piston pins, and embodies features not found in conventional designs. The crankshaft is of the built-up type in which the individual parts are positioned by gear-type face clutches and held together by bolts and special nuts, thus eliminating the necessity for using split connecting rods or main bearings. A newly developed bearing alloy is bonded to the crankpins, main journals, and thrust surfaces of the crankshaft. *Machine Design*, July, 1946, pages 125–128, 7 illus.; "Novel Features of Jack & Heintz Engines," *Automotive and Aviation Industries*, July 1, 1946, pages 18–20, 47, 7 illus.; "Air Cooled Engine," *Mechanical Engineering*, July, 1946, page 654, 1 illus.; "Lightweight Motors Built of Large Aluminum Die Castings," by Kenneth Rose, *Materials & Methods*, July, 1946, pages 83–86, 3 illus.

An Analysis of the Effects of Fuel Distribution on Engine Performance. Donald B. Brooks. Recent work carried out at the National Bureau of Standards showed that certain substitute fuels were poorly distributed in engine manifolds designed for use with gasoline. The article gives the results of a re-examination of the effect of fuel distribution on performance. From an empiric equation, based on single-cylinder-engine test data and relating engine power to fuel consumption, engine-performance curves are derived analytically for typical examples of poor mixture distribution. Investigation of the resulting information shows that the minimum specific fuel consumption is a satisfactory criterion of distribution quality. A method is developed for

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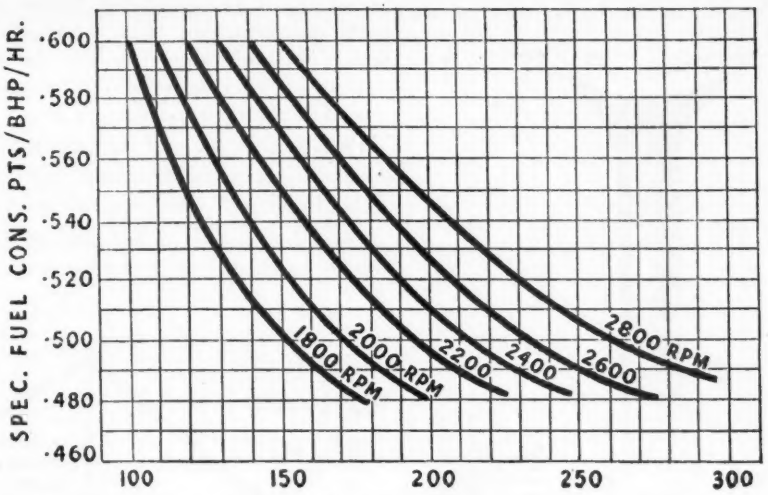
ascertaining the attainable improvement over a given distribution. *Journal of Research of the National Bureau of Standards*, May, 1946, pages 425–439, 10 illus.

Water Injection in a Spark-Ignition Engine. W. P. Green and C. A. Shreeve, Jr. Facts established from past research with regard to the use of water injection as a coolant and detonation suppressor in spark-ignition aircraft engines are enumerated. Information is supplied about tests conducted over a wide range of compression ratios and rates of water injection. The tests were made to obtain additional data on the quantity of water needed to prevent detonation; to determine whether worth-while gains could be made by operating an overcompressed engine without water at low loads, with detonation suppressed in the high-load range by water injection; and to determine the effect of injected water on exhaust temperature and heat loss to the coolant. Details of the tests that were conducted with a single-cylinder, water-cooled N.A.C.A. Universal engine, are set forth. It is concluded that the injection of water into the engine cylinder decreases the maximum pressure and tends to decrease the slope of the expansion line with little or no change in thermal efficiency. Curves in which fuel saving is plotted against b.hp. indicate the desirability of the use of water injection in engines that will operate the greater portion of the time in the low-load range, with only occasional use at full power. Exhaust temperatures are reduced by water injection although a portion (or all) of the normal heat transferred to the cooling water then appears in the exhaust. *Transactions of the A.S.M.E.*, July, 1946, pages 541–545, 11 illus.

A Middle-Weight Power Unit. A new series of Alvis Leonides, nine-cylinder, air-cooled radial engines with an international rating of 430 b.hp. and a maximum rating of 525 b.hp. at 5,000 ft., is scheduled to provide the power plants for the twin-engined Cunliffe-Owen Concordia, a medium air liner. Work on the engines, designated as the L.E.1.M. and L.E.2.M., was interrupted during the war. A brief outline of developments since 1944 is supplied. The L.E.2.M. differs from the L.E.1.M. in that it is equipped to carry a shaft drive to a separate auxiliary gearbox mounted on the aircraft bulkhead, and has a reduction-gear ratio of 0.625 instead of 0.5.

A patent crankshaft assembly has been devised, the essential basis of which is a divided crankpin. The divided crankpin is splined internally and carries a mating and splined steel coupling. Externally a white-metalled steel bearing sleeve is carried on the crankpin and the whole assembly is bolted end-to-end. The sleeve has an internal flange nipped between the crankpin halves and splined to mate with the coupling. In the front crank web is a tapping to take the screwed end of the bolt, which is locked in position on the rear crank web with a locking ring, set screw, and tab washer.



Fuel consumption of the Alvis Leonides nine-cylinder air-cooled radial engine. (See "A Middle-Weight Power Unit.")

Other components briefly described are the head and cylinder-barrel valves, cam-disc, bearings, lubrication system, reduction gear, supercharger and compressor impellers, and the automatic fuel-injector. The article concludes with an account of the development facilities of the manufacturer at Coventry, England. A double page cutaway drawing of the engine identifies the parts by number. A table of specifications is included. *The Aeroplane*, June 14, 1946, pages 697–701, 9 illus.

Kinetics of Chemical Reactions in Flames. Y. Zeldovich and N. Semenov. The theory of flame propagation is developed along the lines followed by Frank-Kamenetsky and one of the writers. The development of chain processes in flames is considered. A basis is given for the application of the method of stationary concentrations to reactions in flames. Reactions with branching chains are analyzed. The case of a diffusion coefficient different from the coefficient of temperature conductivity is treated. Translation from *Journal of Experimental and Theoretical Physics* (U.S.S.R.), Vol. 10, 1940. *National Advisory Committee for Aeronautics, T.M. No. 1084*, June, 1946.

What's the Diff—? Changes in engine-model designations of Pratt & Whitney Twin Wasp D Series (R-2000) engines used in Douglas C-54 and DC-4 airplanes are explained and tabulated. The changes in model number designate either a change of rating or a sufficient structural change to warrant a new number. The table summarizes the most important changes in the various R-2000 models, ranging from the R-2000-3 to the R-2000-2SD13G. In addition to the table, the text lists the two types of ignition harness, the aluminum muffs shrunk onto the cylinder barrels, the bronze exhaust-valve guides, the new piston-ring design, and changes in the bearings. *Douglas Service*, June, 1946, pages 6 and 7.

Engines, Rocket

A Critical Review of German Long-Range Rocket Development. W. G. A. Perring. An extensive analysis is presented of long-range rocket developments in Germany. The scope and history of the German effort are outlined in an introduction to the subject. Reference is made to work that was started at the Peenemunde research and development station on a range of rockets designated A1 to A10, only one of which, the A4, known to others as the V-2, was ever used operationally. The particulars of the A4 rocket are set forth in a table and discussed. Details are supplied about the propulsive unit and fuel system, engine characteristics, design of the controls, and the range. The characteristics of the typical rocket trajectory are described and compared with those of the German rocket. Information is supplied about other German rocket developments. Discussions following the reading of the paper are included. *The Journal of The Royal Aeronautical Society*, July, 1946, pages 483–525, 33 illus.

V-2 Range Control Technique. Thomas M. Moore. The general geometry and launching procedure for the German V-2 rocket is reviewed in an article explaining range control of this weapon. At the nose of the missile is the war head containing the explosive. Behind this is a control compartment that houses means for directing the flight path. Next are two large tanks in tandem containing the alcohol and oxygen. These feed into a combustion chamber and venturi tube and, when ignited, propel the missile. Two sets of control vanes are located at the rear. One set operates inside the jet stream; the other is located on the trailing edges of four large fins and is used also for flight stabilization.

Control range of the rocket is obtained by cutting off the supply of rocket fuel when the rocket has reached a velocity sufficient to carry it to the target

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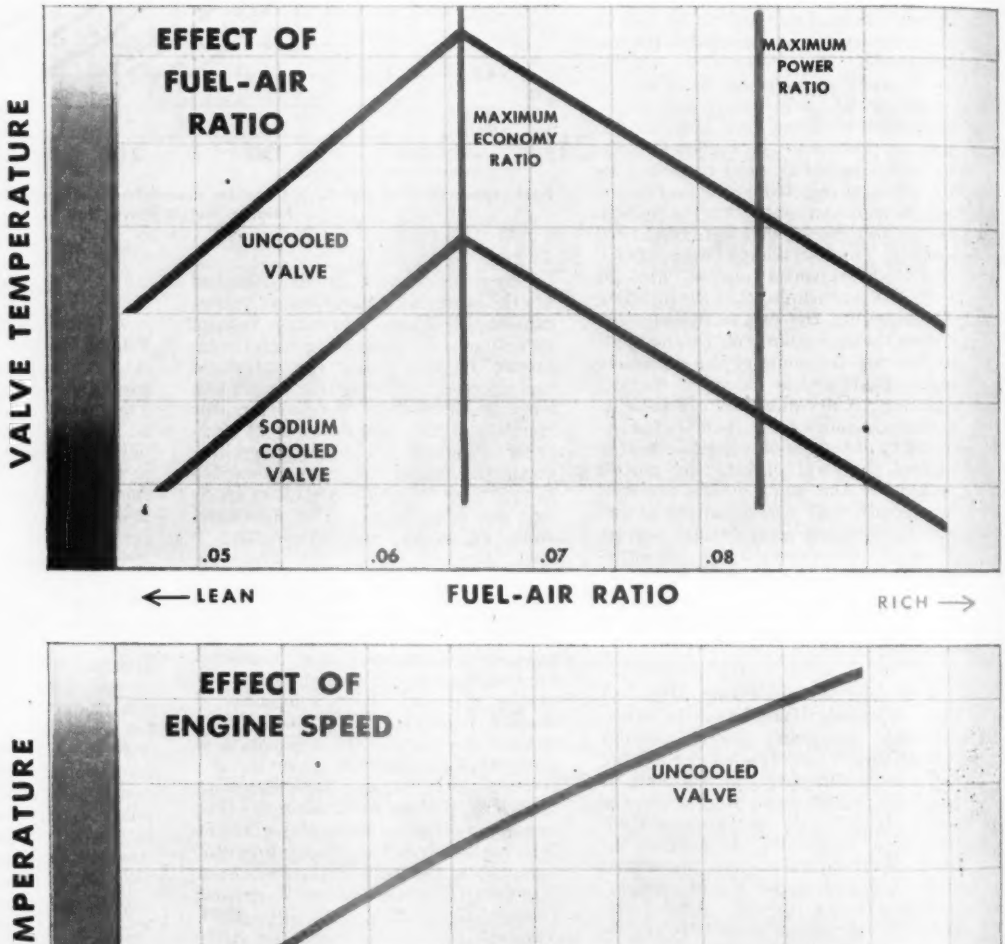

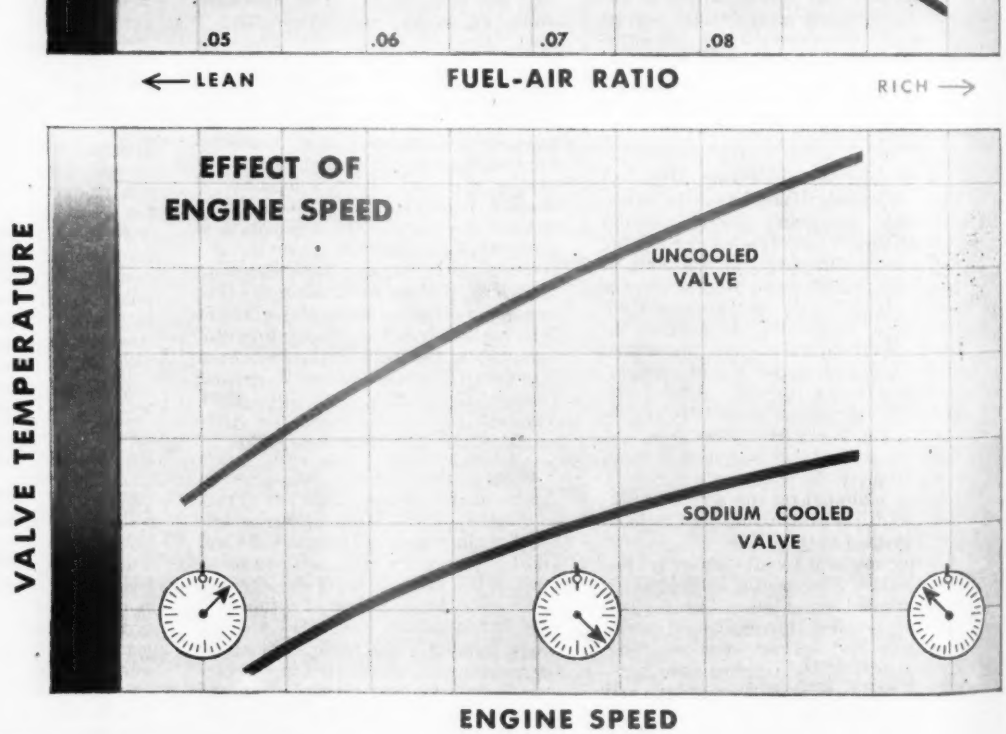

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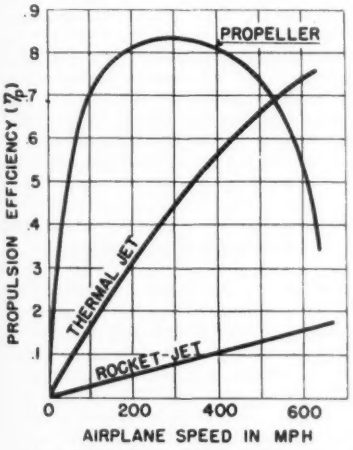
Photographs, diagrams, graphs, and text explain the use of the mechanical integrating accelerometer, the use of the electrolytic integrating accelerometer, and temperature regulation. *Electrical Engineering*, July, 1946, pages 303–305, 6 illus.

The Rocket Powerplant. M. J. Zucrow. Information is given about the fundamentals of rocket jet propulsion and its application to the assisted take-off of aircraft. The discussion is limited to constant-pressure rockets. The characteristics and performance of both the liquid-bipropellant rocket jet propulsion system and solid-propellant rocket engines are described and analyzed. Consideration is given to the factors affecting the thrust, and to thrust and power relationships. The advantages and limitations of the two types of rocket jet propulsion units that have been employed for assisted take-off purposes are discussed. *SAE Journal*, July, 1946, pages 375–388 (Transactions). 30 illus.



Comparison of propulsion efficiencies of propeller, thermo-jet, and rocket jet. (See "The Rocket Power Plant.")

A Liquid-Propellant Rocket Motor. Lovell Lawrence, Jr. Following a general description of the liquid-propellant rocket engine, the writer explains the theory of reaction propulsion. The efficiency of the rocket engine is compared with that of the conventional reciprocating engine. Graphs show the propulsive efficiency versus the ground speed of a rocket for a jet velocity of 6,600 ft. per sec. The overall efficiency versus speed for a conventional engine with propeller as compared with a liquid-propellant rocket engine and its future applications are discussed. *Mechanical Engineering*, July, 1946, pages 615, 616, 636, 5 illus.

Transonic Research. A detailed account of the Vickers rocket-propelled model for investigating sonic-speed flight is presented in an article accompanied by a specification list, photographs of rocket parts, and performance charts. The Vickers model is based on the Miles M.52. A light steel cylindric shell with nose and tail cones, the model is fitted with a wooden wing, tail plane, and fin. Main dimensions are: overall length, 11.83 ft.; diameter, 18 in.; span, 8.1 ft. The interior of the body is packed with fuel tanks, air bottles, radio and radar equipment, autopilot, servo actuators, and in the extreme tail the small rocket combustion chamber. Power is supplied by a bifuel rocket, the fuels being $7\frac{1}{2}$ gal. of C-Stoff (a mixture consisting of 57 per cent methyl alcohol, 30 per cent hydrazine hydrate, and 13 per cent water), and 12 gal. of T-Stoff (approximately 80 per cent hydrogen peroxide and 20 per cent water). The fuel is carried in three cast stainless-steel tanks and is fed to the combustion chamber by compressed air stored at 515 lbs. per sq.in. in three toroidal bottles. The air is delivered to the tanks through a reducing valve. The combustion chamber is a light steel cylinder about 18 in. long by 6 in. in diameter, with a coned open end, and is lined with a $\frac{3}{8}$-in. wall of carbon cemented to the shell with a special ceramic paste. In the cone end the carbon is increased in thickness to provide a venturi-profile ejector-nozzle, the nozzle throat diameter being about $1\frac{1}{2}$ in. and the mouth diameter about $3\frac{1}{2}$ in., while the length from minimum throat diameter to the mouth is approximately 4 in. The fuel system is described in detail, and the fuel consumption is said to be 17.2 lbs. per hour per lb. thrust. For the fuel carried, this gives a total thrust of 800 lbs.

In use, the model will be carried up to 36,000 ft., suspended beneath a Mosquito airplane which will then release it and break away rapidly. On release the autopilot takes control and puts the model into a 10° dive for 15 sec., causing a drop in altitude to about 35,000 ft. At that point it levels out and a bursting diaphragm releases the compressed air from the bottles, and the fuels are fed to the combustion chamber to give the required thrust, accelerating the model up to sonic speed in 18 sec., beyond which it continues to accelerate up to its maximum speed of 880 m.p.h. After the fuel is exhausted (70 sec.) the power is turned off, the model decelerates to subsonic speed, and the autopilot locks the tail plane down so that the device dives into the sea. The research data are transmitted to a ground station so that the necessary information is obtained during flight. The specifications are tabulated. *Flight*, July 11, 1946, pages 36–38, 10 illus.

Is the Sky the Limit? Frank J. Malina. Research work that has been directed toward the development of sounding rockets for carrying out investigations of the upper atmosphere is reviewed. It is stated that the need for information about the upper atmosphere has been brought about by modern developments in meteorology, radio communication, aviation, long-range guided missiles, and nuclear physics. It is pointed out that ideas for a sounding rocket were implemented in December, 1944, when the Ordnance Department requested the Jet Propulsion Laboratory of the California Institute of Technology to design and construct a prototype model for the use of the Signal Corps. This model was required to carry 25 lbs. of instruments to an altitude of at least 100,000 ft. A conservative estimate of the factors entering into the design of such a vehicle was made and it was concluded that the requirements could be met. As development of the vehicle proceeded, material reductions in estimated empty weight were achieved, so that by the time firing tests were initiated at White Sands Proving Ground, New Mexico, in September, 1945, the vehicle, known as the WAC Corporal, reached an altitude of approximately 230,000 ft. The requirements for a rocket for carrying instruments to the upper atmosphere are discussed. *Army Ordnance*, July-August, 1946, pages 45–48, 6 illus.

The Mechanism of the German Rocket Bomb ("V2"). W. G. A. Perring. Following some brief comments about the history of German rocket developments, the writer describes construction features of the V-2 bomb and gives details about its performance characteristics. In addition to photographs and diagrams of the various components of the rocket bomb, there are charts showing the performance characteristics of the venturi, a typical trajectory, and rocket behavior in the upper atmosphere. Comparative data on a high-speed bomber, flying bomb, and rocket bomb are included. *Journal and Proceedings of the Institution of Mechanical Engineers*, June, 1946, pages 93–100, 23 illus.

Fire Prevention

Fire Suppression. The components of the Graviner fire-fighting system are explained, and a typical installation, suitable for a four-engined aircraft, is outlined. The crash-switch, under an acceleration of 6*g* or more, automatically initiates the following operations: the discharge of all intake extinguishers; the discharge of all spray-pipe extinguishers to smother fire in engines and accessories; and the operation of dinghy-jettison or other safety devices. For light planes, only one extinguisher bottle per engine is employed.

Methyl bromide is the extinguishing agent used in the system. The extinguisher bottles are hermetically sealed after filling and can be discharged only by electrical means. Operation of the extinguisher is effected by the electrical ignition of a fuse, which detonates a small charge in the head. Diagrams and text explain the detonation system fully. The flame detector comprises a metallic capillary tube enclosing a pyrotechnic core, one end of the tube being sealed and the other end attached to a switch. *Flight*, June 20, 1946, pages 629–631, 6 illus.

Flight Testing and Performance

More About the P-92. A brief account is given of the construction of the scale flying model of the Boulton

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Paul P-92. The reasons for the development of a scale model were primarily that of testing the effect of the large turret, with its guns, on flight characteristics, and the assessment of the general prospects of a long-range escort fighter. A deviation from the scale was required in order to provide space for the pilot, and special attention was paid to the cowling to obtain a fair simulation of the Sabre engine installation of the full-sized airplane. The 3-hour flight test was said to be successful although difficulty was experienced with overlightness of the rudder and elevators. However, it is thought that in any larger aircraft the heavier loads would have balanced the situation. Several minor design problems are discussed. *Flight*, June 20, 1946, page 622.

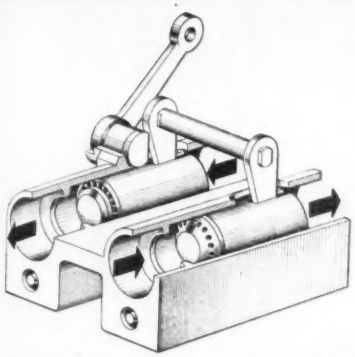
Gliding and Soaring

Glider Towing Hooks and Releases. B. S. Shenstone. This serial article is devoted to a study of the hooks and releases required for towing gliders and catapulting them from the ground. Consideration is given to developments in design and the advantages and disadvantages of the various types. The first installment is devoted to hook types, including the simple open hook, dual purpose hooks, and internal hooks. *Soaring*, July-August, 1946, pages 6, 7, 11, 9 illus.

Hydraulic Equipment

Compact Hydraulic Unit. The Electrol, Inc., Powerpak is a new hydraulic device that combines in one compact unit a complete hydraulic system consisting of hand pump, two separate four-way selector valves, relief valve, and reservoir. In units now in production, power is supplied by a hand pump. However, ports for connecting pressure and suction lines of a power-driven pump are provided when such an installation is desired. The device weighs only 5 lbs., employs standard pipe plugs throughout, and has been designed for simple, inexpensive maintenance. The design conforms to Army, Navy, and commercial standards. Its compactness is indicated by the fact that exclusive of the handle the unit stands only $4\frac{1}{2}$ in. high and its base measures only $3\frac{1}{2}$ by 4 in. It can supply operating pressures up to 1,500 lbs. per sq.in. Flow from the hand pump amounts to $\frac{7}{8}$ cu.in. per cycle and the flow from an engine pump may be up to $1\frac{1}{2}$ gal. per min. *Electrol, Inc.*, Kingston, N.Y.

Hydraulic Fuses. The Simmonds Quantity-Measuring Type Fuse and Return-Flow Type Fuse serve as safety shutoff devices to provide protection in the event of a break or rupture in the hydraulic line, and neither fuse affects the normal operation of the system. The quantity-measuring fuse is designed to shut off after a predetermined amount of fluid has passed through. The return-flow fuse, installed between the pressure and return lines, shuts off only if a break in one of



Operating principles of Simmonds return-flow type hydraulic fuse.

the two lines causes a pressure drop below predetermined values.

Fuses for lines from 1/4 to 3/4-in. outside diameter are available. The quantity-measuring fuse is available in capacities that will protect cylinders of from 50 to 100 cu.in. *Simmonds Aerocessories, Inc.*, Long Island City, N.Y.

Ice Prevention

An Empirical Equation for the Coefficient of Heat Transfer to a Flat Surface from a Plane Heated-Air Jet Directed Tangentially to the Surface. John Zerbe and James Selna. An investigation of the heat transfer to a surface from plane heated-air jets discharged tangentially to the surface was conducted to provide heat-transfer relationships required in the design of heated-air jet installations for aircraft windshield fog prevention. Experimental temperature, velocity, and heat-transfer data were obtained by tests in which the initial jet temperature and velocity were varied from 101° to 156°F. and from 52 to 218 ft. per sec., respectively. The jets were produced by three nozzles of different depths, namely, 0.102, 0.313, and 0.547 in.

The resulting data were correlated to yield relationships for the maximum profile jet velocities and temperatures, and the coefficients of heat transfer from the jet to the surface, in terms of the nozzle-exit jet velocity and temperature and of the distance from the apparent jet origin. The test results are presented in tabular form and the correlations of the data are illustrated graphically. *National Advisory Committee for Aeronautics, T.N. No. 1070*, June, 1946.

A Method of Constructing the Paths of Raindrops of Different Diameters Moving in the Neighbourhood of (1) a Circular Cylinder; (2) an Aerofoil, Placed in a Uniform Stream of Air; and a Determination of the Rate of Deposit of the Drops on the Surface and the Percentage of Drops Caught. Muriel Glauert. The investigation reported has been undertaken with a view to determining the paths of raindrops of different sizes (1) in front of a circular cylinder, and (2) near the nose of an airfoil, moving in a uniform stream of air. The rate of deposit of the drops on the surface was also calculated and the percentage of drops caught was determined.

Such an investigation was suggested by Prof. G. I. Taylor in "Notes on Possible Equipment and Technique for Experiments on Icing on Aircraft," *R. & M. No. 2024*, January, 1940, dealing with the problem of deicing. In that paper he develops the equations of motion for a raindrop moving in a steady stream of air whose velocity components parallel to stated axes are known at any point of the fluid. He considers two cases (a) when the drag coefficient may be taken as constant, and (b) when the drops are so small that they obey Stokes' law of resistance. After some investigation it was decided that case (b) was more suitable for the present calculations. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 2025*. British Information Services, New York, $0.75.

Electrically Heated Rubber. The subject of electrically heated rubber in airplane applications is treated in a 4-page folder. With heated rubber it is possible to apply a thin, tough, abrasion-resistant "skin" to almost any irregular or regular shape and produce controlled heat in exactly the right places to meet ice removal or prevention requirements. Heated rubber is now being used on propellers, cowling, air scoops, antenna masts, spinner domes, pitot masts, direction finders, and other exposed parts.

Application of heated rubber to propellers is described. The heating elements applied to the leading edges of the blades are light in weight, smoothly faired, and fitted. Each unit consists of thin plies of synthetic rubber and suitable resistance wires. Heat concentration is readily confined to the desired pattern and the electrical resistance remains constant. The design provides for greater heat dissipation in the immediate leading edge where ice accumulation is heaviest. It is stated that the propeller shoes are abrasion-resistant and protect the leading edges against sand, pebbles, and cinders. They can be directly cemented to metal, wood, or plastic-covered blades. *The B. F. Goodrich Company.*

Instruments, General

A Moisture-Control System for Aircraft Instruments Containing Vacuum-Operated Gyros. E. R. Dye and R. J. W. Koopman. Two methods for combating moisture condensation on aircraft instruments containing vacuum-operated gyros are explained. The two particular situations causing this condition occurred during overnight layovers when the air became relatively cool, thus leaving moisture on the delicate parts; and when in descent from high altitudes the parts remained cool while the air became warmer.

The first problem was solved by utilizing and improving upon the moisture-absorbing capsule method. The device consists of a perforated tube, surrounded by a heating coil, which is attached to the air-intake line of a vacuum-operated instrument. When the instrument is not in operation, the capsule removes moisture from the still air in the instrument just as a pickling plug removes moisture from the air in an engine cylinder or crankcase.

For the second problem a device has been constructed to alleviate water condensation on descent. It consists of a water jacket surrounding a central air passage, a condensed-water reservoir, and a ceramic drain plug through which the condensed water can drain when the system is not in operation. The central air passage is connected vertically in the air-intake line ahead of the absorbing capsule. A detailed description explains the principle of operation. *Instruments*, July, 1946, pages 400, 401, 6 illus.

"High-Altitude" Testing Equipment. Two new models of high-altitude testing units have been added to the Bowser line of laboratory temperature, humidity, and vacuum processing equipment. One of the new units has a maximum efficiency of 1 in. mercury absolute, or 75,000 ft. of altitude, while the other model provides an efficiency of 2.7 in. of mercury absolute, or an equivalent of 55,000 ft. of altitude.

The 75,000-ft. altitude unit features a climb rate of 2,500 ft. per min. up to 55,000 ft. In the 55,000-ft. unit the climb rate is increased to 5,000 ft. per min. up to 55,000 ft. Each unit can be "dived" at a rate of 55,000 ft. to sea level in 2 min. Twelve cu.ft. of testing space provide ample room for the instrument and material testing, which can be observed through a heavy glass door. These altitude units are powered by a 110–220 volt, single-phase, 60-cycle motor, and operate economically for production, laboratory, or processing work. *Bowser, Inc., Refrigeration Division*, Terryville, Conn.

Profilometer Reading Recorder. A new reading recorder, operating as an attachment to the profilometer, provides a continuous chart record of the average roughness of the surface being measured. The charts, which read in microinches like the profilometer microinch meter, are useful in obtaining more detailed information on surface roughness, such as the location of rougher or smoother areas, and in providing records of the surface finish on parts. The recorder attaches at the meter jack provided on all profilometers. *Physicists Research Company*, Ann Arbor, Mich.

Aircraft Test Equipment. A 4-page folder contains condensed descriptions and specifications of instruments for testing various aircraft components and equipment. Among those mentioned are the mercurial barometer, air-speed manometer, vacuum and pressure chamber, altimeter calibration stand, ball-bearing cleaning machine, precision levels, and a compass card magnetizer. Other instruments described are the rate-of-climb balancing stand, compass-card balancing and calibration stand, manifold mercury manometer, and a high-voltage tester. *Strata Instrument Company*, Long Island City, N.Y.

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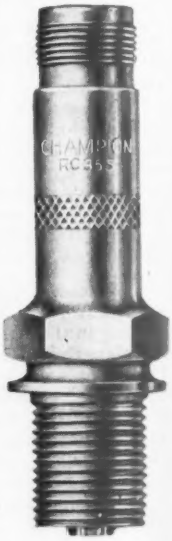

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Instruments, Flight

Toward Automatic Flight. A compilation of diagrams and explanatory data describes the function of a number of navigation instruments, devices, and procedures used in flight. The booklet is intended to indicate the present trend toward automatic flight. *Bendix Radio Division of Bendix Aviation Corporation.*

Instruments, Meteorological

Differential Wind Speed Analyzer. James J. and John F. Riley. In an attempt to provide more accurate average wind speeds for a large airport, a differential wind-speed analyzer has been devised to subtract one wind speed from the other. A three-position switch on the indicator provides means for securing readings of wind speed at either of the anemometers and the differential wind speed. *Aero Digest*, July, 1946, page 111, 2 illus.

Landing Gear

Single-Disc Brake for Aircraft Landing Wheels. Particulars are supplied about a brake for aircraft landing wheels developed by Goodyear Tyre and Rubber Company (Great Britain), Limited. Characteristics of the brake, which is of the single-disc type, are stated to be simplicity of construction, ease in maintenance, rapid heat dissipation, and light weight relative to its capacity for absorbing energy. *Engineering*, June 28, page 608, 2 illus.

Lubrication and Lubricants

Positive Action Lube System Proved for Goodyear F2G. V. S. Kupelian. Construction details and advantages of a lubricating system that has been specially developed to supply uninterrupted flow to engine parts during all flight maneuvers are described. During early flight tests of the Goodyear F2G Navy fighter, it was observed that the oil pressure indicator dropped to zero after any flight configuration resulting in negative acceleration of the airplane. It is stated that the condition occurred to a marked degree because of increased oil flow inherent in the large engine, a Pratt & Whitney Wasp Major. The increased oil flow left little reserve to be used if the main body of oil were removed from the tank by negative acceleration. Some of the devices investigated in attempts to overcome the difficulty are reviewed, together with their considered deficiencies. Details are supplied about the maneuver-type lubricating system developed, which is devoid of any moving parts in the tank and can be used with a tank of any size or shape in any location. *Aviation*, July, 1946, pages 66, 67, 3 illus.

Maintenance

Service Program for Douglas Transports. A booklet describes the service program that Douglas Aircraft Company, Inc., offers in connection with the manufacture and delivery of its transport-type aircraft. Sections are devoted to the field service representative, plant service, engineering-service liaison, service publications, service equipment, maintenance training, service analysis, serviceability, and service centers. *Douglas Aircraft Company, Inc.*

Materials, General

Model K Dillon Universal Tester. A 15-page booklet designed to help in the calculations of material testing when using the Dillon Universal Tester is provided by the engineers of the company. The booklet contains a set of tables showing the factoring of specimen tests for materials. *W. C. Dillon & Company, Inc.*, Chicago.

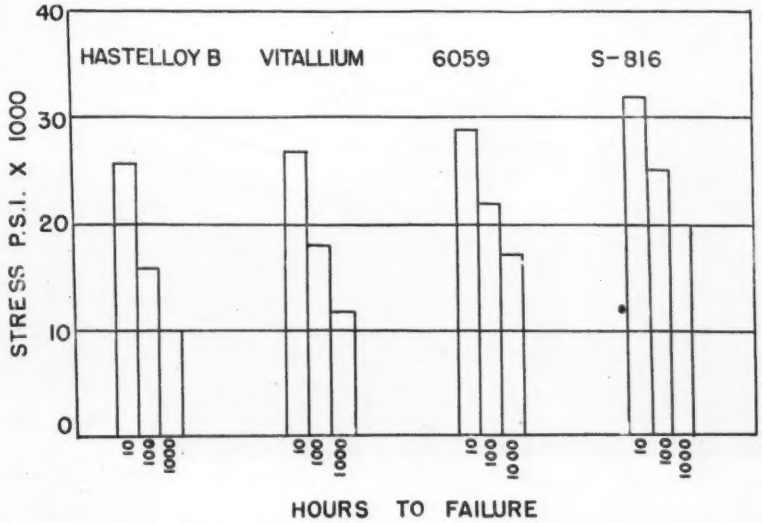
A Procedure for Testing the Locking Effectiveness of Self-Locking Nuts and Related Fastening Devices is the title of a 16-page booklet prepared by Dr. J. A. Sauer, Head of the Department of Engineering Mechanics, Pennsylvania State College. It describes in detail the equipment and procedure for making tests for vibration, installation and removal torque, re-use torque, and wearing and plating. *Elastic Stop Nut Corporation of America*, Union, N.J.

Materials, Metals and Alloys

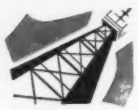
Metallurgical Development of Materials for Turbosuperchargers and Aircraft Gas Turbines. W. L. Badger. The metallurgical development of alloys suitable for the severe high-temperature service requirements of aircraft turbosuperchargers, from the SAE alloys 2335 and 6150 up to the present-day Timken and Vitallium alloys, is reviewed in Part I of this two-part article. The improvement in stress rupture values of wheel material and bucket alloys over the past quarter century is graphically illustrated. Some of the other difficult metallurgical problems that were encountered in the development of the supercharger are described.

Part II discusses problems of grain size in cast buckets, the mass effect of large forgings, the effectiveness of inspection methods, center cracks in wheel forgings, the conservation of alloys, and distortion in magnesium parts. *The Iron Age*, July 25, 1946, pages 40–45, 5 illus.; August 1, 1946, pages 60–66, 8 illus.

The Spot Welding of Multiple Thicknesses of 0.040-In. Alclad 24 S-T. W. F. Hess, R. A. Wyant, and F. J. Winsor. This study of the spot welding of multiple thicknesses of 0.040-in. Alclad 24S-T is another in a series of research investigations of the spot welding of aluminum alloys conducted at the Rensselaer Polytechnic Institute Welding Laboratory. As a result of the work it is stated that the spot welding of four thicknesses of 0.040-in. Alclad 24S-T should be carried out commercially only under carefully controlled conditions. In a four-thickness joint, spot welds of adequate shear strength with freedom from such defects as cracks, expulsion, and excessive sheet separation can be produced only over an exceedingly narrow range in welding current. Using optimum welding conditions, spot welds of good quality in four thicknesses of 0.040-in. Alclad 24S-T may be produced over a current range of only 3,000 amp. The corresponding current range for



Average stress-rupture values at 1,500°F. on aircraft gas-turbine bucket alloys. (See "Metallurgical Development of Materials for Turbosuperchargers and Aircraft Gas Turbines.")



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two thicknesses of this material, using optimum welding conditions, is approximately 15,000 amp.

The jointing of five thicknesses is not considered feasible using present methods of spot welding. It is difficult to produce any fusion at the outside interfaces because of the rapidity with which heat is extracted by the electrode tips, and when such fusion is obtained it is done so only at the expense of considerable expulsion at the center interface. The results of this investigation reveal that preferably only adjacent sheets should be stressed and, if possible, stress should be confined to those at the center of the joint. The stressing of other than adjacent sheets should be avoided since the eccentricity of the loading increases the tension component of stress on the weld. This decreases the allowable load that the joint may carry, since spot welds are considerably weaker in tension than in shear. Stress should be applied to the center sheets in preference to the outer sheets because the diameter of the weld at the center is almost invariably larger and more consistent than the diameter at the outside interfaces.

With spot facings less than $1^1/_2$ in. care should be taken to insure that machine settings are not based on the results of single-spot test specimens, which have been welded individually. Tables and graphs summarize the findings. *The Welding Journal*, July, 1946, pages 413-s–424-s, 18 illus.

Metallurgical Characteristics of Spot Welds in Magnesium Alloys. Frederick J. Winsor. The article deals with general principles of spot-weld metallography and more specifically with the metallographic structure of spot welds in the three commercially available chemical compositions of magnesium alloys. The designations of these alloys and their thermal properties are presented in a table. The typical mechanical properties of the alloys also are shown in tabular form. Consideration is given only to the metallurgical nature of spot welds in the 0.040-in. thickness of these materials, since experience has shown that the type of structure is independent of the thickness of the material. Photomicrographs of welds in these alloys are shown. *Aluminum and Magnesium*, July, 1946, pages 10–13, 18, 20, 21, 15 illus.

Decarburization in Highly Stressed Steels. P. A. Haythorne. Decarburization and its effects on the properties of heat-treated, highly stressed aircraft steels are evaluated. The writer describes research work carried out to establish a suitable method of determining the true extent of decarburization effects and to find means of overcoming decarburization troubles. He also describes a new technique for the accurate determination of surface carbon depletion. *The Iron Age*, July 4, 1946, pages 52–61, 26 illus.

Factors Controlling the Strength of Brazed Joints from Final Report N.R.C. 560. C. Rhyne, Jr. This report gives results of experiments on the strength of furnace-brazed joints with copper as the brazing metal. It is particularly concerned with data that may be used in aircraft subassemblies. The parent metals are limited to SAE 4130 and SAE 1010 steels. Joints of aircraft tubing in sizes from $^1/_4$ to 3 in. have been investigated, with particular emphasis on the 1 by 0.120-in. wall tubing. Some results on tube-to-tube joints and ring and plug joints are included. The most predominant factor contributing to the strength of a joint is shown to be the deformation of the parent metal at the time of the failure of the bond. The average ultimate stress of the bond may vary between approximately 45,000 lbs. per sq.in. at 0 stress for high-strength steels, to 17,000 for SAE 1Q10 steel when the tensile stress of the parent metal approaches its ultimate value.

Factors investigated as contributing to the strength of the joints were: area of bond; finish of surfaces; clearances between the mating members; protective atmosphere during brazing; time of brazing; parent metal of members; heat-treatment after brazing; contamination of surface; diameter and thickness of members; misalignment of brazed members. The text is supplemented by photographs, tables, and charts. *The Welding Journal*, July, 1946, pages 599–611, 14 illus.

Welding Stabilized 18-8 Stainless. R. J. Haften. It is noted that in early attempts to weld 18 chromium-8 nickel stainless steel, the susceptibility of the weldment to intergranular corrosion presented a serious problem. Heat-treatment after welding would restore resistance to corrosion but this was not always possible or practical. The article describes how stabilizing this steel with columbium or titanium eliminates intergranular corrosion caused by heating the steel to the sensitizing range. In a microstructure study of phase changes occurring during welding, it is shown that the formation of ferrite in the austenite grain boundaries adversely affects the physical properties. *The Iron Age*, July 11, 1946, pages 60–64, 9 illus.; "Some Investigations of 18-8 Stainless Steel," by Wilson G. Hubbell, *Steel Processing*, July, 1946, pages 455–459, 5 illus.

Further Investigation of the Effect of Spot Welds on the Sheet Efficiency of Alclad 24S-T. W. F. Hess, R. A. Wyant, and F. J. Winsor. The investigation reported is a continuation of a preliminary investigation of the effect of spot welding on the sheet efficiency of single-spot specimens of the stressed- and unstressed-attachment types in 0.040-in. Alclad 24S-T, in which earlier work the specimens were subjected to static loads and were studied by means of the fatigue and the stress-strain record methods. The present investigation has been developed from that study, to include both single-spot and multispot specimens of the stressed-attachment and unstressed-attachment types in 0.020, 0.040, and 0.064-in. Alclad 24S-T subjected to dynamic as well as static stresses.

The data for the sheet efficiency specimens subjected to static loads were obtained by the stress-strain record method that was fully described in the preliminary report, and the data for the sheet efficiency specimens subjected to pulsating stresses were obtained in a direct-stress machine. Tension impact tests on both shear and sheet efficiency specimens were carried out in a pendulum-type impact machine modified for this purpose. Throughout the investigation the test results constantly demonstrated that weld quality is by far the predominating factor in the effect of spot welds on the properties of Alclad 24S-T. The conclusions are summarized and the results of the tests are discussed. *The Welding Journal*, July, 1946, pages 361-s–375-s, 10 illus.

Two New Low-Temperature Silver-Brazing Alloys. Two new silver-brazing alloys featuring lower silver content are called Easy-Flo 45 and Easy-Flo 35. The numbers designate the percentage of silver in the alloy, whose other components are copper, zinc, and cadmium. One of its features is a new low melting range of 1,120° to 1,145°F. The 35 per cent alloy has characteristics quite different from Easy-Flo 45. It has wider melting range of 1,115° to 1,295°F. and is free flowing at an exceptionally low temperature for an alloy containing 35 per cent silver. It offers an opportunity for manufacturers to produce joints economically between ferrous or nonferrous metals which are high in strength and ductility, and is appropriate for use in places where a higher working temperature is not objectionable. *Handy & Harman*, New York.

Materials, Plastics and Plywood

Low-Pressure Laminating. A. Burness, E. G. Williams, and R. Hammond. An analysis is presented of Nuron 100, a cross-linking, liquid resin that has been developed by the I.C.I. Ltd. Plastics Division. Nuron 100 was primarily designed for use as a contact or low-pressure laminating resin but the possibilities for general-purpose impregnating and casting with this class of resin are suggested. The desirable characteristics of a good contact resin are summarized in eleven points, all requirements of which are said to be met by Nuron 100. Some of the advantages mentioned are rapid curing time; slight likelihood of poisoning operators; and absence of free styrene, which is undesirable owing to its volatility and relatively high toxicity.

In a discussion of the technique of laminating, the writers state that contact-pressure resins are suitable for

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the construction of shaped laminated articles, and where high strengths are required laminated glass-fiber fabric has been found to give excellent results. The resins may also be used with ordinary cotton fabrics or paper. Properties of the laminate are determined to a large extent by the nature of the fabric used. The two principal methods of laying up are explained. With either method the mold surface should be covered with a parting agent and an impervious film placed between the plies and the rubber bag. In the application of Nuron 100 the main use will probably be in the construction of large-shaped laminated articles and in the production of aircraft parts and ducting. *British Plastics*, June, 1946, pages 274a–278, 4 illus.

Design Tolerances for Transparent Acrylic Plastics. Practical tolerances for the machining, forming, assembly, and installation of acrylic plastic parts are discussed. It is noted that because of their clarity, acrylic plastics are used for airplane enclosures, safety guards, and inspection windows. The writer describes methods of mounting and fastening parts made from transparent acrylics. Design considerations when using inserts also are discussed. *Product Engineering*, July, 1946, pages 110, 111, 5 illus.

Medicine

Limits of Factors of Safety in the Human Body. Eugene F. Du Bois. The writer observes that the principle of providing large factors of safety, which is well-known to engineers, was well-taken care of by nature in its development of the human body but that there are fairly well-defined limits to these factors of safety, which in a few parts of the body are dangerously small. The hope is expressed that engineers will consider man as a vital part of the machine with definite limits in structure and function. Examples are given of some of the problems presented by airplanes that approach the speed of sound. The effects on the pilot of centrifugal force when the plane is turning, of rapid ascent, descent, and acceleration are discussed. Consideration is given to problems of oxygen supply and the efficiency of men and machines. *Mechanical Engineering*, July, 1946, pages 625–627.

Meteorology

High-Altitude Meteorological Research. Lt. Comdr. Daniel F. Rex. A practical application to "high-altitude" meteorology is discussed in its relation to rocket-propelled missiles. The writer states that forecasts of the physical state of the upper atmosphere are necessary in order to solve adequately the rocket ballistic problem and to evaluate the effect of atmospheric conditions upon guiding mechanisms. The described program of high-altitude research (defined in this article as between 100,000 and 500,000 ft.) is subdivided into four related projects which are discussed separately: (1) the selection of quantities to be measured; (2) the design and construction of instruments suitable for taking such measurements; (3) the design and construction of a vehicle of sufficient range and capacity to reach the desired altitudes; and (4) the actual collection and evaluation of data.

Meteorological attention with regard to these extreme altitudes is focused on two subjects—a study of insolation and its effect upon the atmosphere, and an investigation of the circulation prevailing at these heights. Although suitable basic instruments have in most cases already been designed, three factors peculiar to rocketsonde operation must be considered. First, a tremendous amount of energy is dissipated into the atmosphere immediately surrounding the rocket in flight, with the exception of the highest point of its trajectory. Therefore, any measurements made near the rocket body will be subject to distortion. Second, the time interval available for measurement at any intermediate level is extremely short, since an average speed of from 2,000 to 4,000 ft. per sec. will be maintained during flight. Third, the recovery of data will of necessity depend upon the successful operation of a rapid-sequence telemetering system at extreme ranges, and for certain measurements the instrument itself must be retrieved. The requisites for a partial solution to these problems are supplied by the writer and an outline of present organization in the field indicates the extent to which the work has progressed. Mention is made of the contemplated organization of a High-Altitude Rocket Sounding Advisory Panel. *The Bulletin of the American Meteorological Society*, June, 1946, pages 328–330.

Science and Weather During the War: A Summary of Forecasting Progress. Wing-Comdr. R. M. Poulter. The writer reviews the advances in weather forecasting during the late war, with particular reference to observations taken over the sea areas around the British Isles where wartime necessity increased vastly the number of observations taken. Sections are devoted to the use of radiosondes in forecasting conditions in the upper air; forecasting the risk of lightning and gale damage to barrage balloons; the use of radio receivers at well-spaced stations to track thunderstorms and "atmospherics," and the extension of the time range of forecasts. *Quarterly Journal of the Royal Meteorological Society*, July-October, 1945, pages 391–396.

Progress in Icing Research. Capt. Edward J. Dolezel, Robert M. Cunningham, and Robert E. Katz. This paper presents a nontechnical survey of the research being done on the meteorological aspects of aircraft icing. The organization of the program and the functions of four installations in the United States are indicated. After a short qualitative discussion of the flow around cylinders, several new specialized instruments are described, and the theory developed to interpret their data is treated briefly. The purpose of the article is to indicate the nature of the advancements being made toward solution of the problem of aircraft icing. Information now being obtained is intended to aid both the airplane designer and the meteorologist. In addition to the special data, photographic records are made of an auxiliary panel containing many of the meters commonly found on an airplane instrument panel. In the future, weather reconnaissance airplanes will be equipped with rate-of-icing meters that will enable them to furnish reports of existing icing hazards. Another contribution mentioned is a theory to explain the growth of cloud particles in the sizes found in drizzle and rain. Also, measurements of the drop size in clouds can be carried on simultaneously with experiments on radar weather sets to get information about the effect of particle size on the presence and intensity of the echo. *The Bulletin of the American Meteorological Society*, June, 1946, pages 261–271, 8 illus.

Lightning Recorded by Aeroplane Propeller. J. M. Bryant and M. Newman. Theories and explanations are offered for the characteristics and effects of lightning that struck the propeller blades of an airplane in flight. A complete record of the interception of the discharge by the moving blades was found in the pit marks in the metal. The lightning-current direction was also recorded by magnetization of the steel retaining rings at the base of the blades. From its character, it is believed that the stroke was from cloud to cloud rather than from cloud to ground, in which case it would be the first recorded data on such a stroke. Photographs showing the pit marks on the blades are reproduced. *Journal of Applied Physics*, July, 1946, pages 555–557, 5 illus.

Synoptic Climatology. Woodrow C. Jacobs. Recent and current research is described in detail, dealing with the developmental methods for accomplishing a synoptic or synchronous climatology which attempts to reduce the doubtful, mean-climatic picture into the actually occurring weather patterns of which climate is composed. As a result of continued research, the Weather Division of the Army Air Forces developed an objective form of weather-map classification, based on the airflow at the gradient level. The final plan for the synoptic climatology is illustrated in diagram form. The system requires

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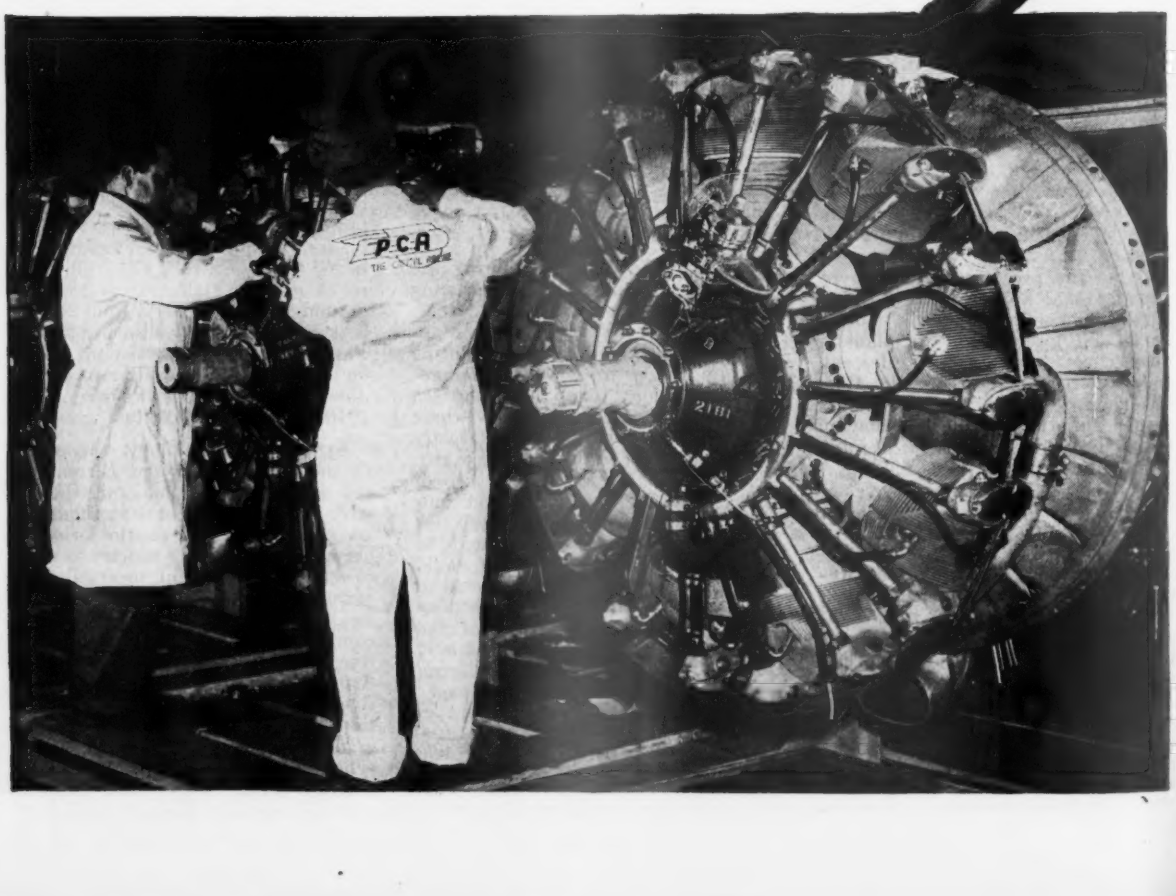
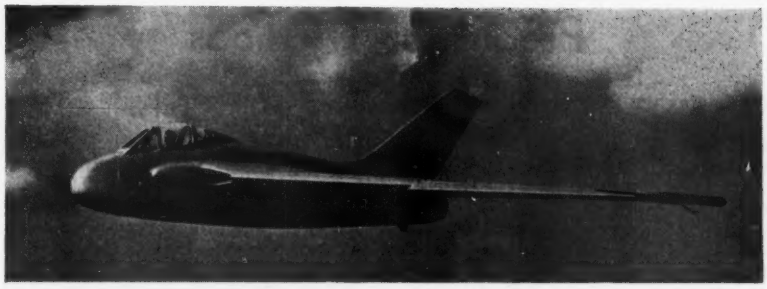


geographic divisions of such size that each can be described by a single direction of gradient airflow; historical weather maps studied to classify an area; a summary of all data providing the trend of weather maps studied, to classify an area; a summary of all data providing the trend of weather conditions, over any designated period; and the probable percentage of accuracy of a forecast. A typical situation, with the resulting forecast, is provided as an example. *The Bulletin of the American Meteorological Society*, June, 1946, pages 306–311, 2 illus.



The de Havilland 108 tailless jet airplane. This experimental plane has fully sweptback wings, but does not have horizontal tail surfaces. The sweptback wing is designed to delay the onset of compressibility sufficiently to permit higher speeds without loss of control.

Military Aviation

Man-Made Meteors. J. L. H. Peck. A survey of existing and proposed pilotless aircraft also reviews the participation of remote-controlled bombers during the war. The robot that guided these planes is described as to function and operational limitations. The system of "television telemetering" instrument readings, used in the Army's controlled fighters, is examined. Several rockets are referred to with brief descriptions. The VB-10 Roc bomb features a "shroud" that is bent around the bomb's body in cylindric form instead of projecting sidewise as does a regular wing. Control is afforded by tilting the shroud in the desired direction. It has only slightly less lift than a straightened-out wing of equal area. The X Roc is "cruciform" and consists of two short narrow-chord wings that form an X, with the body of the bomb in the center. The trailing half of each wing is hinged, and full-span trailing-edge trim tabs are attached to the gyro-stabilized ailerons. "Little Joe," a new Navy design for surface-to-air operation is of similar but more advanced design than the X Roc. It features canard cruciform wings and cruciform "tail" in the front. Both wings and tail are fitted with narrow, hinged control surfaces. This rocket-powered missile is radio-controlled and equipped with a VT proximity fuse.

Large telescopic wings are being designed for V-2 type missiles, which can be extended after the flying rocket reaches the top of the trajectory, enabling long-distance glides with power off. The hazards of the existing phenomena in the ionosphere are given, and the use of radar in this work is discussed. *Air Force*, August, 1946, pages 45–47, 60, 6 illus.

Our Jet Air Force. Leon Shloss and David P. McNamara. An article on present and proposed jet-propelled aircraft of the Army Air Forces gives a list of ready and pending types of jet aircraft. Other jet-power applications are discussed. Consideration is given to the future of ram-jet engines. It is stated that the ram-jet engine appears to be the most suitable engine to defeat the high-fuel rates involved in supersonic flight.

The training of personnel for the jet air force also is mentioned. The advantages of jet propulsion are outlined. *Popular Science*, August, 1946, pages 82–86, 12 illus.

Pyrotechnics for ASR. A history of the use of pyrotechnics reviews the uses of that type of communications during World War II. Developments in the field of pyrotechnics for the Navy, Coast Guard, Army Air Forces, and Royal Air Force are described. The equipment described includes pistol-rocket signals, float smoke signals, distress smoke hand signals, and day-and-night distress signals. *Air Sea Rescue Bulletin*, NAVCG 128, U.S. Coast Guard, June, 1946, pages 18–22, 51, 6 illus.

Parachutes

Dynamic Tensile Tests of Parachute Webbing. Ambrose H. Stang, Martin Greenspan, and Sanford B. Newman. The results are reported of comparative tests on various types of parachute webbing conducted by the National Bureau of Standards at the request of the Bureau of Aeronautics, Navy Department. Dynamic-load-stretch and stretch-energy data were obtained for two types of nylon and one type of cotton parachute webbing. These data were compared with similar data obtained from static tensile tests of the materials. The dynamic and static breaking strengths of the webbing also were obtained.

The nylon specimens showed a reduced strength, stretch, and capacity for energy absorption under dynamic loading as compared with static loading.

The cotton specimens showed under dynamic loading about the same strength, reduced stretch, and increased energy absorption as compared with static loading. The energy absorbed by the broken nylon specimens was more than three times that of the broken cotton specimens. *Journal of Research of the National Bureau of Standards*, April, 1946, pages 411–419, 3 illus.

Production, General

Motion Economy. Parts II and III. F. C. Bailey. The last two installments of a three-part article demonstrates the application of motion study to small-batch manufacture in the aircraft industry. In Part II the writer gives examples of production procedure planned from the outset on motion-study principles and also shows how a moderately satisfactory compromise may be reached by modifying an existing procedure after motion analysis.

In Part III he shows how motion study has suggested improved methods of handling aircraft assemblies, particularly in the case of small riveted components. He describes flexible tools evolved for mass-riveting of such parts after two-handed prepositioning of the rivets by the operator.

He also describes the ultimate development indicated by his investigations, namely, a tool that in a single operation will pierce the material, position the rivets, and close them. *Aircraft Production*, May, 1946, pages 225–229, 6 illus.; July, 1946, pages 330–334, 12 illus.

Production Methods in Glider Manufacture. William Schweizer. Problems connected with the manufacture of gliders on a production basis are considered. It is stated that if there is sufficient demand for gliders they can be produced and sold at a price comparable to that of a light airplane, less the engine and related accessories. It is pointed out that the overall glider market is dependent on the ease with which people can participate in gliding and soaring, education of the public to the value of gliding and soaring, and bringing this method of flying within the means of the public. Design factors affecting the cost of the glider are discussed. Consideration is given to the setting up of the tooling and production planning program. The importance of interchangeability of parts and assemblies in the production of low-priced gliders is stressed. *Soaring*, July-August, 1946, pages 4, 5, 10, 1 illus.

Production Methods

Welding the Stainless Alloys in the "Shooting Star" Jet Engine. W. J. Campbell. Welding was selected as the method of fabricating the sheet-metal parts in the G-E Type I-40 turbojet engine, which are made from austenitic alloys because of their high strength and corrosion resistance at temperatures up to 1,500° and 1,800° F. How some of the difficulties encountered in welding these alloys were met is described in sections devoted to carbide precipitation, cracking, and distortion. Information is given about the method of removing oil, dirt, and grease from the parts to be welded. *Steel Processing*, July, 1946, pages 431–435, 10 illus.

De Havilland Goblin II. Part I. J. A. Oates. Production methods used in the manufacture of gas turbine-jet aircraft engines are described in a serial article on the de Havilland Goblin II. As a prelude to the subject, the writer outlines the constructional features of the power plant and explains the theory of operation. It is pointed out that while the gas turbine has fewer working parts than the piston engine, the standards of accuracy and quality of surface finish called for in its manufacture are extremely high. Machining, inspection, and balancing operations on the impeller are described in detail and illustrated. The operation schedule for the Goblin II impeller is given and the form of chart used when checking the vane thickness is shown. *Aircraft Production*, July, 1946, pages 311–320, 24 illus.

Effect on Fatigue Strength. W. Ker Wilson. The effect of surface finishing on the fatigue strength of aircraft-engine components is considered. It is stated that operational experience with aircraft engines indicates the rarity of failures from purely material defects but emphasizes the decisive influence of surface finish on resistance to loadings that are mainly dynamic. Typical service failures of aircraft engines are described and illustrated with photographs. The influence of cutting, grinding, and polishing operations on fatigue strength is discussed. The effects of various treatments on fatigue strength, including case hardening, nitriding, cold rolling, shot-blasting, and surface plating are reviewed. *Proceedings of the Institution of Mechanical Engineers*, Vol. 153, 1945, War Emergency Issue No. 10, pages 347–351.

Some Aspects of the Welding of Stainless Steels. J. A. McWilliam. Corrosion-resisting steels are classified and their welding characteristics are discussed. Information is supplied about the oxyacetylene and resistance methods of welding 18/8 stainless steels. Other welding processes also are considered. Typical applications of welded stainless steels are described and illustrated, including an exhaust manifold for a Spitfire plane made of 18/8 steel containing titanium. *Sheet Metal Industries*, July, 1946, pages 1369–1374, 1382, 16 illus.

Heat Treatment of Aluminum Alloy Castings. E. Carrington. An elementary discussion on the theory and practice of the heat-treatment of aluminum alloys is presented. Particular attention is paid to the various forms of furnaces available for this purpose, to their operation, and to factors governing the selection of any given type. The principles of heat-treatment are explained, including special methods for particular alloys. Information is supplied about the planning of a heat-treatment program, muffle furnaces, pit furnaces, furnace management, the keeping of heat-treatment records, and heat-treatment for stress relief. *Light Metals*, July, 1946, pages 336–342, 3 illus.

Results of Modern Practice. F. Nourse. The Quality Manager, Engine Division, Bristol Aeroplane Company, Ltd., discusses methods of producing and evaluating surface finishes on aircraft-engine components. Consideration is given to the measurement of surface finish in its application to manufacture and quality control. Cases where the surface finish is critical for satisfactory performance are cited. Reference is made to instruments that have been found to be particularly useful in the measurement of surface finishes. *Proceedings of the Institution of Mechanical Engineers*, Vol. 153, 1945, War Emergency Issue No. 10, pages 344, 345.

The Welding of Non-Ferrous Metals. Part VII. The welding of magnesium alloys is further treated in a continuation of Part VII of a serial article on nonferrous metal welding. Consideration is given to the design of joints in magnesium-alloy sheet, the preparation of the edges, and setting up the parts for welding. The preheating of castings is discussed. Particulars are supplied about welding procedure. Other sections deal with the use of protective treatments and the properties of gas-welded joints. *Sheet Metal Industries*, July, 1946, pages 1375–1382, 13 illus.

How to Weld Aluminum. Modern techniques employed in the welding of aluminum are set forth in four serial articles prepared by the engineering staff of Reynolds Metals Company.

The first article of the series describes in detail the weldability of various aluminum alloys and the technique of gas welding. A table gives the nominal mechanical properties for aluminum sheet products. Torch welding data for aluminum of various thicknesses, and data on weld-rod sizes and the minimum tensile strength of gas-welded aluminum alloys also are supplied.

In the second article, modern techniques of arc welding aluminum are discussed. Consideration is given to metal arc, manual and automatic carbon arc, atomic hydrogen, and inert gas shielded arc welding methods. Recommendations are made with regard to electrode size and type, joint edge preparation, and general operating technique.

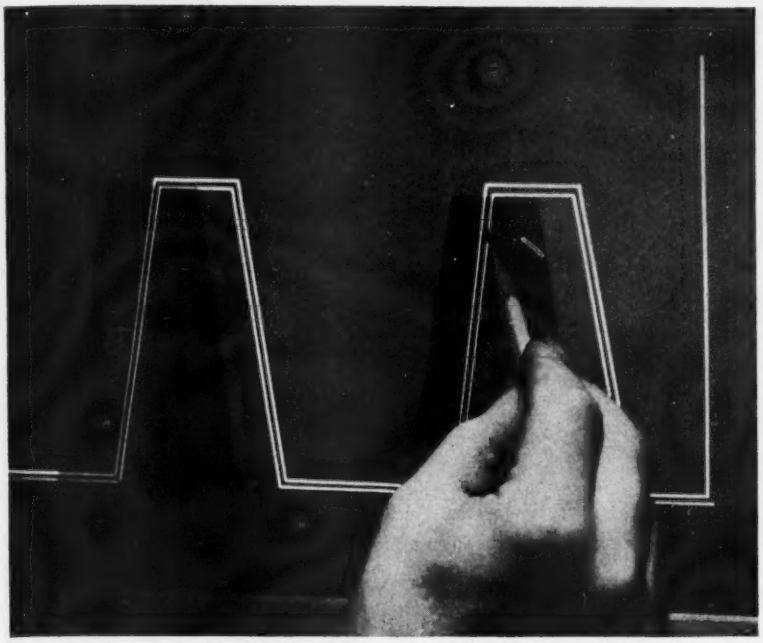
The application of spot welding to aluminum alloy and the different types of machines used are described in the third article. Attention also is given to the subject of adequate preweld cleaning. The various methods of cleaning are considered, along with the advantages and disadvantages of each. Information is also given about machine settings, electrode maintenance, and trouble shooting.

The fourth article deals with modern seam and flash welding methods, soldering, and brazing by the furnace, dip, and torch methods. Cleaning operations before and after brazing, and the final inspection of joints also are discussed. *The Iron Age*, June 20, 1946, pages 50–55, 5 illus.; June 27, 1946, pages 60–64, 6 illus.; July 4, 1946, pages 67–71, 2 illus.; July 11, 1946, pages 53–57, 4 illus.

Continuity in the Production of Specified Surface Finish. E. Swain. The article deals with finishes on aircraft-engine parts obtained with standard equipment. It is stated that to maintain a continuous flow and trouble-free assembly, with perfect interchangeability, manufacturing tolerances must be well conceived with a tendency to be close, and that a high standard of finish is synonymous with close tolerances where a high standard is required. The manufacturing technique used in the plant of Vauxhall Motors, Ltd., is described. The importance of the grinding machine in the obtaining of close tolerances is emphasized and surface-grinding operations are described. A comparison is made of present standards of surface finish with the results obtainable with superfinishing methods. *Proceedings of the Institution of Mechanical Engineers*, Vol. 153, 1945, War Emergency Issue No. 10, pages 345, 346, 11 illus.

Production Tools and Equipment

Unit Construction. It is noted that recently there has been a trend in certain quarters to the adoption of a unit system of machine-tool construction. One of the main objects of such a system is the flexibility available in adjusting machine-tool capacity to changing requirements of design. A description is given of a system of units for universal application in the building up of jigs and fixtures of any type, which has been newly developed by the firm of



The Kodak green scribing plate developed for use with optical comparators of the contour projection type. Tolerance lines are scribed on the plate by cutting through a transparent green-dyed gelatine coating applied to glass. The tolerance lines are transparent, with lines in shaded areas appearing as red through the use of a supplemental red light behind the plate. In this picture the piece under examination has been shifted to illustrate how lines in shaded areas are brought into sharp relief. The plates may be used directly with comparators or as printing masters.

Wharton and Olding Ltd. of Welwyn Garden City. It is known as the Wharton Universal system and comprises 22 classes of units, each available in a number of variations and giving a total of 1,132 elements. Essentially the system consists of building up jig and fixture structures, using standardized elements of precision, each series of elements being designed to perform some definite function within the structures. Interchangeability between the elements is obtained by using tenons, either integral with the element or fitted separately, locating with tenon slots or tee-slots accurately machined for width and centers. The elements are attached to a base, or to one another by tee-bolts held in tee-slots cut in the various surfaces of the bases and elements. Provision has been made for expansion of the built-up structure in all directions to accommodate any shape of component. *Aircraft Production*, July, 1946, pages 324–329, 17 illus.

German Die Castings Made by Hot Shot Gooseneck Method. J. R. Townsend. It is explained that the discovery of some remarkable die castings in captured German radio communications equipment led to a search by an American commission surveying German industry for the machines used to manufacture them. The source of the castings was found to be the Mahler Werke, of Fellback, near Stuttgart. The writer describes the machines and the quality of the castings produced. The machines are designed to produce "hot shot" aluminum and magnesium die castings. It is stated that the manufacture of magnesium die castings by this method is remarkable and that the use of 15,000 lbs. per sq.in. air pressure presents some hazards. One of the machines is being sent to America for study. *Product Engineering*, July, 1946, pages 81–83, 6 illus.

Machining Engine Valves. Part I. A two-part article describes the tooling used by the Ford Motor Company, Ltd., in the manufacture of valves for the Merlin engine. The unusual procedure of using five-spindle chucking automatics for most of the machining operations on the inlet and exhaust valves was adopted. Reference is made to the difficulties inherent in separately machining each end of the valve and employing alternating locations, with attendant overlapping of tolerances. These difficulties include the maintenance of concentricity and endwise location. Three stages in the machining of the sodium-filled exhaust valves are discussed. *Aircraft Production*, July, 1946, pages 335–342, 15 illus.

Aircraft Tools. A catalog showing aircraft tools used in building and maintaining airplanes and the machines that make them contains diagrams and photographs in addition to descriptive information. It refers to rivet tools, dimpling tools, angle drills, cutting tools, miscellaneous tools, and bucking bars. *Aircraft Tools, Inc.*, Los Angeles.

Propellers

How the Controllable-Pitch Propeller Increases Personal Airplane Utility. Peter Altman. It is stated that the personal airplane is essentially an intercity vehicle, and as such, to attain utility, it must have good take-off, climb, and cruising performance, all of which can be materially improved through the use of a controllable-pitch propeller. Types of controllable-pitch propellers now available for the personal airplane are described. The technical details of how the controllable-pitch propeller improves airplane performance are studied by means of simple formulas and charts. Sections are devoted to take-off, climb, ceiling, and level-flight performance. Seaplane applications of the controllable-pitch propeller are mentioned and operation precautions are suggested. *Automotive and Aviation Industries*, July 15, 1946, pages 22–25, 52, 54, 7 illus.

Junior Rotol. A small, light, two-bladed, controllable-pitch feathering propeller for light aircraft is described. Pitch-change motion is available in two ways: (1) purely manual, with actuation by a handcrank in the cockpit; and (2) electrical, by means of a three-position switch in the cockpit controlling a remotely mounted electric actuator. Blades are made of compressed wood by Jablo and are screwed into steel adapters in the conventional Rotol manner, with rotary and centrifugal loads taken by two-row ball-bearing stacks, the inner-row balls being of larger diameter than those of the outer row. The transfer unit is essentially a single-ball race enclosed in a fabricated housing comprising outer and inner members, the former remaining stationary while the latter rotates with the propeller. The total installed weights are respectively 60 lbs. 8 oz. for the electric type and 55 lbs. 4 oz. for the manual type of propeller. *Flight*, June 27, 1946, pages 646–648, 7 illus.

Propeller-Hub and Regulator Combination Test Rig. A combination propeller-hub and regulator test rig designed for checking Aeroproducts propeller Models A 642-G1 and A 642-G2 is identified as Model T-133. The function of this combination test stand is to test the hydraulic functions of variable-pitch propellers. The tests that can be performed on this stand are: (Test Regulator)—(1) pressure-control valve opening pressure; (2) pump flow; (3) maximum control speed of governor; (4) governor sensitivity; (5) external and internal leaks; (Hub Test)—(1) external and internal oil leaks; (2) general operation; (3) rate of pitch change (timer). *Hydraulic Machinery, Inc.*, Dearborn, Mich.

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Radio

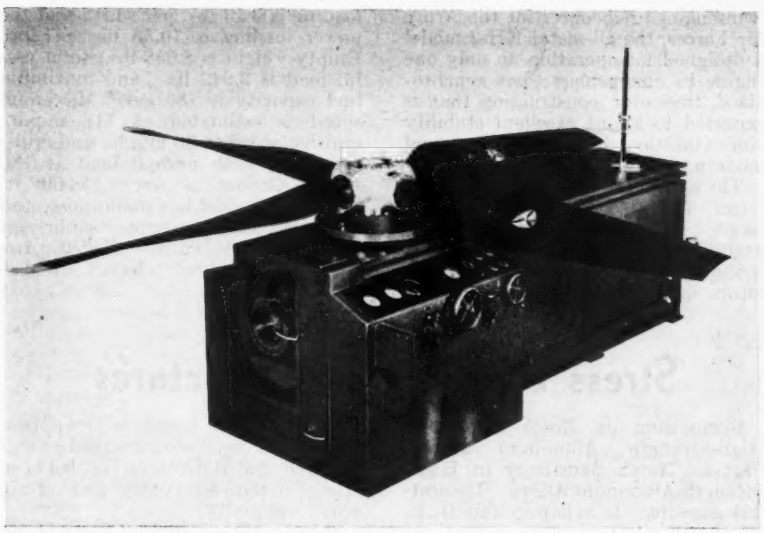
Aircraft Electronics Progress. Lawrence LeKashman. A survey of present and future applications of electronics to civil aviation states that the equipment in use today is identical with that in use prior to the war. It is stated that the trends are clearly established, however, and it can be expected that the next several years will be a period of slow but steady transition to new equipment. The writer feels that the most promising radar developments so far have been in traffic-control equipment for use at airports and along airways. The existing systems mentioned are loran, the SCS-51 system; Ground Control Approach; and V.H.F. radio-range stations. *Aero Digest*, July, 1946, page 63.

A Wild-Goose Chase. Carlos B. Mirick. Early experiments with radio-controlled aircraft and descriptions of the equipment used at the Naval Research Laboratory are reviewed. Work was first begun at the U.S. Naval Air Station, Anacostia, in 1922 as a part of the Aircraft Radio Laboratory group. Work was transferred to the Naval Proving Ground at Dahlgren, Va., and installation of equipment was commenced in an N-9 seaplane which had already been equipped with gyro-actuated automatic controls. A description of the equipment used includes weights and dimensions. An account of the flight test of the plane, the Wild Goose, states that the plane covered a distance of 2 to 3 miles and achieved an altitude of between 200 and 500 ft. *United States Naval Institute Proceedings*, July, 1946, pages 947–951, 2 illus.

Rotating Wing Aircraft

Water Operations. S/Lt. A. E. Bristow. Some of the problems of overwater operation of helicopters are discussed in an article explaining the take-off and landing procedures to be followed. A high standard of concentration and an accurate judgment of height are stated to be two paramount considerations in helicopter water operations which require special attention by the pilot and maintenance crews alike. To simplify beaching the aircraft on floats, a special cradle of tubular steel structure was designed, enabling the aircraft to be rolled down the slipway straight into the water without further manipulation. It is considered unwise to attempt water landings in exposed areas with wind speeds above 20 m.p.h. or when the waves are white crested. *American Helicopter*, July, 1946, pages 12, 13, 33, 4 illus.

Practical Engineering of Rotary Wing Aircraft. Part I. Paul H. Stanley. The first of a series of articles in which problems of rotating wing aircraft design are analyzed gives detailed information about the fundamental knowledge that has been gained from the development of the autogiro. The principles employed in successful helicopters are explained. Predictions bearing on future developments are made. Consideration is given to important aspects of loads developed in hub-driven helicopter blades. The writer describes methods of determining the relative drag distribution, torque absorbed by the blades, the elementary forces acting on them, and the resultant bending moments. Structural and performance data on outstanding helicopters built since 1900 are presented in a table taken from the magazine *Luftwissen*. *Aviation*, July, 1946, pages 55–65, 14 illus.



Model T-133 combination propeller hub and regulator test rig designed by Hydraulic Machinery, Inc. **(See Propeller-Hub and Regulator-Combination Test Rig, page 65.)**

What's Ahead for the Helicopter? Devon Francis. A survey of the future development and utilization of helicopters includes aircraft costs, the legal aspects, and future designs. The writer reviews the optimistic forecasts for helicopter developments and compares present achievements. Estimates are made for the initial cost of private helicopters, maintenance costs, fuel consumption, and the traffic difficulties. Because of the difference in operational procedure and flight routes, rotating wing flying will involve new legal difficulties, especially in the matter of air traffic. These problems are discussed in detail. *Air Force*, August, 1946, pages 24–27, 63, 6 illus.

Gyrodynetics. Two helicopter projects, interrupted by the war in 1939, are described. The plans were inaugurated by Cierva Autogiro Company Ltd. and its licensee, G. & J. Wier, Ltd. The Weir Gyrodyne, Type W.7, was a helicopter, while the Cierva project was an intermediate design that could operate either as a helicopter or an autogiro. The W.7 project employed an offset propeller with its axis in the horizontal position, the thrust of this propeller counterbalancing the torque reaction of the rotor. The engine was to drive, through a primary clutch, a mechanical differential gear that divided torque evenly between the rotor and the propeller. Yawing control was by brakes or clutches on the differential shafts.

In the Cierva project two propellers were to be used for forward propulsion, with the propeller on the side where the rotor blades were advancing permanently geared to the rotor, while that on the retreating side had a clutch mechanism so arranged that when the rotor clutch was engaged, the propeller was disengaged. If the craft were to be flown as a gyroplane, both propellers would provide propulsion, the rotor autorotating as in the autogiro. Rudder control was by pedal, pitch being increased on one propeller and decreased on the other.

Of the other refinements visualized for the Cierva Gyrodyne, mention is made of a governor for controlling the mean pitch angle of the rotor blades and for keeping rotor speed constant. This was to operate similarly to the hydraulic mechanism of the de Havilland constant-speed propeller. *Flight*, June 13, 1946, page 592, 2 illus.

Transport or Cargo Helicopter. With a gross weight of 11,600 lbs. and two 550-hp. Continental engines, the Kellett KH-2 type helicopter will be capable of carrying ten passengers, in addition to a pilot and copilot, or will handle cargo loads of one ton or more. Initially it will be offered to transport operators supplying air transport between midcity or residential areas and outlying airports used by commercial air lines.

Based in part on designs arising from the construction of the XR-10

twin-engined helicopter for the Army Air Forces, the all-metal KH-2 model is designed for operation on only one engine in emergencies; has synchronized, two-rotor construction that is expected to afford excellent stability and vibration characteristics; and modern transport styling.

The new craft will be offered in two forms, for passenger service or for cargo. Its principal dimensions are overall width, 69 ft. 4 in.; length, 65 ft.; height, 19 ft. The intermeshing rotors are 65 ft. in diameter, disc loading is 3.13 lbs. per sq.ft., and the power loading is 10.55 lbs. per hp. Empty weight is 8,658 lbs., total useful load is 2,942 lbs., and maximum fuel capacity is 180 gal. Maximum speed is estimated at 118 m.p.h., cruising speed at 90 m.p.h., and cruising range with normal load at 180 miles. Ceiling is over 15,000 ft. The cargo model has main, nose, and auxiliary cargo compartments aggregating 589 cu.ft. *Kellett Aircraft Corporation*, North Wales, Pa.

Stress Analysis and Structures

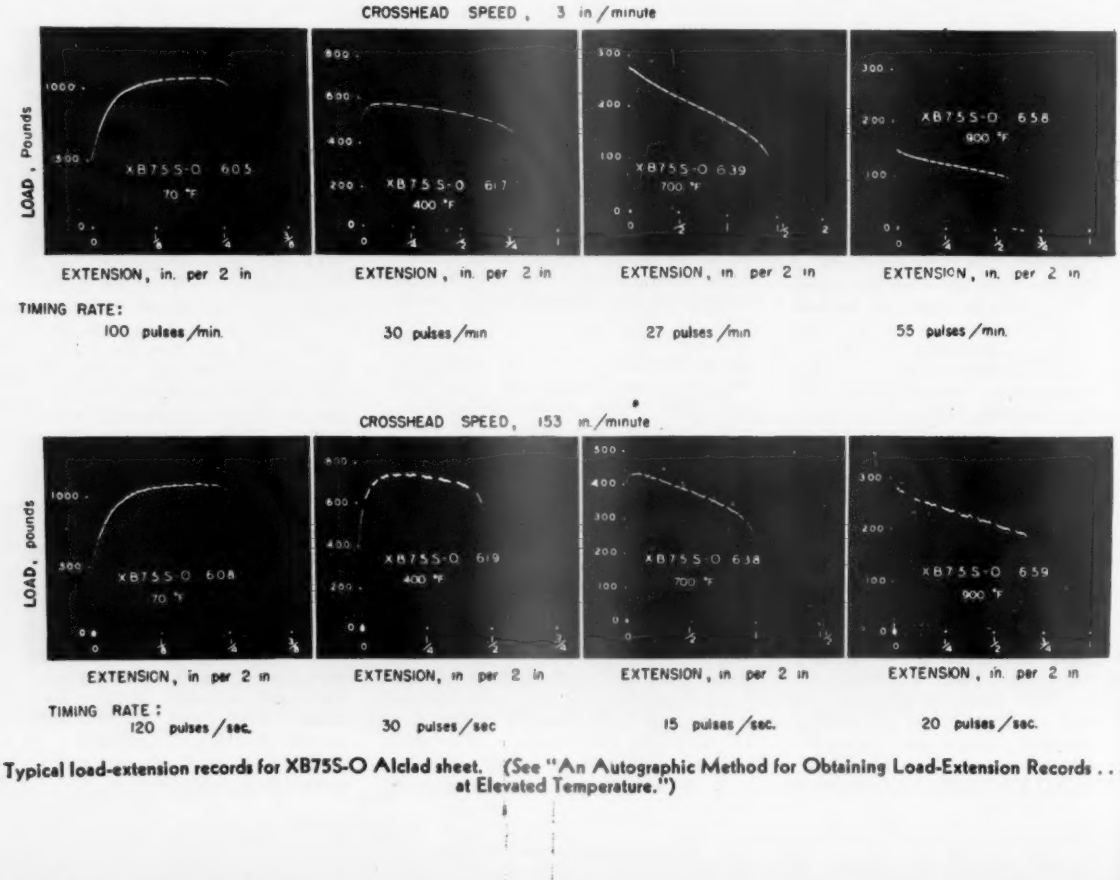
Symposium on Notch Effects in High-Strength Aluminum Alloys. Part I: Notch Sensitivity in High-Strength Aluminum Alloys—Theoretical Aspects. L. Schapiro and H. E. North. A study has been made of the effect of various types of notches and notched depths on static ultimate tensile strength of 14S-T, 75S-T, and 24S-T aluminum alloys. An ideal stress notch insensitive material is defined in terms of a logarithmic relationship between notched ultimate stress and notch depth. Test data indicate that the logarithmic relationship is a good first approximation and that a scale of stress notch sensitivity may be established. Alloy 75S-T is shown to be more stress notch sensitive than 14S-T, and alloy 24S-T more sensitive than either. Caution in the commercial application of this conclusion is urged as well as need for differentiating between stress notch sensitivity and strain notch sensitivity.

Part II: The Effects of Open Holes on the Tensile Strength of Some Aluminum Alloys. C. H. Stevenson. Experimental data are presented to show the effect of holes on the ultimate tensile strength of 14S-T, 24S-T, and 75S-T aluminum alloys. Variations in efficiency of from 75 to 105 per cent are shown for the different alloys and products. Curves useful in design are given to show the effect of single and multiple holes of various sizes in plate, bar, and extrusion.

Part III: Notch Effects in High Strength Aluminum-Alloy Spar Caps. D. L. Moseley. For spar caps having an area of 4 to 6 sq.in. and with 15 to 25 per cent of this area removed by bolt holes, the average net area efficiency was 85 per cent for 14S-T billets and 91 per cent for 75S-T extrusions.

Part IV: The Effect of Notches Upon Limiting Strain in High-Strength Aluminum Alloys. O. A. Wheelon and St. J. Barrett. Bending tests were conducted on $\frac{1}{8}$-in. square, notched bars of 14S-T, 24S-T, and 75S-T. It was found that notches of any depth drastically reduce the limiting strain for all materials tested and for all testing temperatures. The effect of notches upon the formability in bending is more severe in the case of 75S-T than in the case of 24S-T. Heating appreciably increases the limiting strain under notch conditions for the two artificially aged alloys, 14S-T and 75S-T. A true solution of the notch problem is dependent upon a fuller knowledge of rupture conditions under triaxial stresses and upon knowledge of the effect of notch geometry upon the stress state. *Journal of the Aeronautical Sciences*, August, 1946, pages 391–404, 31 illus.

An Autographic Method for Obtaining Load-Extension Records of High-Speed Tensile Tests on Sheet Specimens at Elevated Temperatures. Alan E. Flanigan, Leslie F. Tedsen, John E. Dorn, and H. R. Kaiser. An apparatus has been developed for obtaining load-extension records of tensile tests on sheet specimens at ele-



Typical load-extension records for XB75S-O Alclad sheet. (See "An Autographic Method for Obtaining Load-Extension Records .... at Elevated Temperature.")

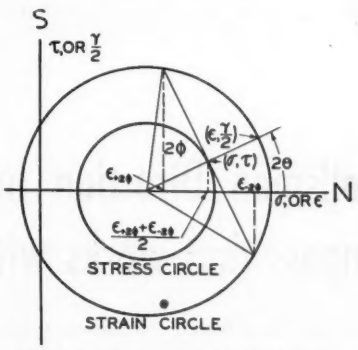
vated temperatures. It has been used successfully at temperatures up to 900°F. and at strain rates as high as 1 per sec. Difficulties are encountered, however, in determining the load at fracture. Typical results are shown to illustrate the effects of testing temperature and strain rate on the load-extension curves for XB75S-O Alclad sheet. *Journal of the Aeronautical Sciences*, August, 1946, pages 405–409, 8 illus.

Numerical Transformation Procedures for Shear-Flow Calculation. Stanley U. Benscoter. Several methods of calculation of shear flows in multicellular members are explained and illustrated. These numerical methods may be used in place of the usual process of solving a system of linear algebraic equations. The processes will have a special appeal to those structural engineers who are familiar with moment distribution because of the similarity in the method of performing the computations. A transformation procedure may be learned and applied by a designer without any knowledge of the equations that govern the solution. The physical significance of the numerical constants involved in the shear-flow problem are emphasized in order to assist the reader in remembering the processes. A mathematical proof of the validity of the procedures is given in an appendix. *Journal of the Aeronautical Sciences*, August, 1946, pages 438–443, 6 illus.

A Closed-Vessel Installation for Determining the Rates of Burning of Propellants. James Taylor and Robert Wark. Details are given about the design of the closed vessel, made from a single ingot of Vibrac steel; the pressure gage; and the optical accessories. The method of calibrating the pressure gage is described, together with results. A description of the experimental method of carrying out a combustion cycle and examples of the type of pressure-time records obtained are supplied.

The installation described has been in operation continuously since 1930 and has proved to be both convenient and reliable in operation. The feature that distinguishes it from previous equipment is the method of optically magnifying the extremely small movements of the pressure member (Petavel type), without any mirror or mechanical levers. This enables a light, robust, short-time period gage to be constructed which gives high quality pressure-time traces capable of accurate measurement, and which for many purposes is believed to be as accurate as the piezoelectric gage installations. The discussion is divided into the following sections: the closed vessel; the pressure gage; optical method and apparatus for recording gage movement; the camera; synchronization of camera opening and firing; illumination; time marking and measurement of records; calibration of closed-vessel pressure gage; and the experimental method. *Journal of Scientific Instruments*, June, 1946, pages 115–118, 8 illus.

Stress Diffusion Problems. W. J. Goodey. It is noted that according to Saint-Venant's principle, the distribution of stress in a body at points remote from the region of application of the applied loads is independent of the mode of application of these loads, being dependent only on their resultant. It is pointed out that while the principle leads to simple formulas for stresses and displacements, these formulas will not usually be valid right up to the points of application of loads, unless the latter are appropriately distributed over the surface of the body. In fact, the stresses near the points of application of loads will depend mainly on the mode of application of these loads, though the influence of their mode of application will become less—usually rapidly so—as the distance from the points of application increases. General equations are developed for a plane sheet reinforced in two directions at right angles. The investigation is then extended to the case of a reinforced cylindric shell by making a simplifying assumption. The diffusion of end load in a flat panel is discussed. *Aircraft Engineering*, June, 1946, pages 195–198, 5 illus.



Circles for stress and strain showing how a V-type stress gage averages two strains to yield an output proportional to the normal stress existing in the direction of its axis. The V-configuration is not essential to stress-gage operation but is perhaps the most convenient, besides being most easily proved by graphic means. (See "Stress Gages Simplify Analysis.")

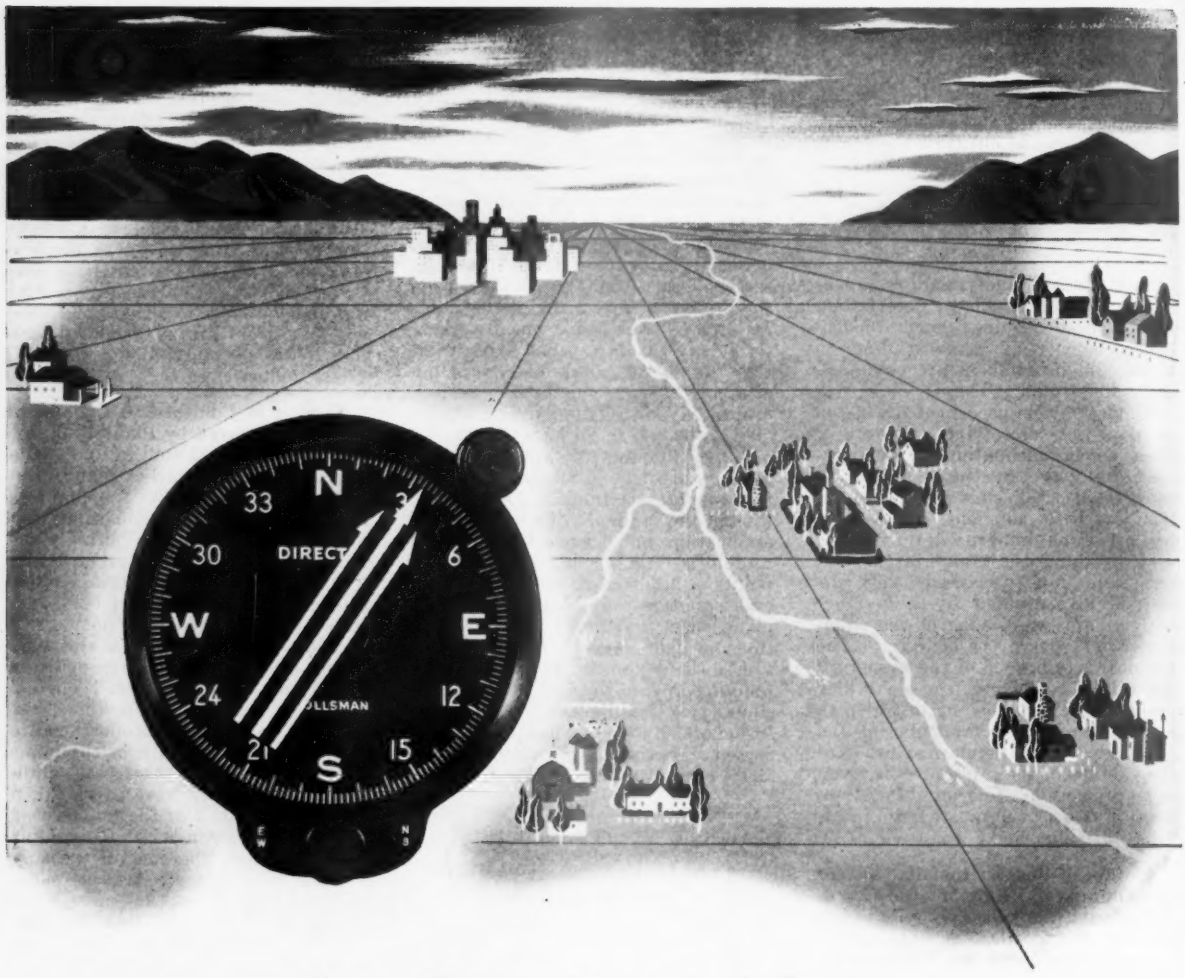
Stress Gages Simplify Analysis. Sidney B. Williams. Because strain measurement does not give a direct indication of stress in many cases, such as in propeller blades subjected to complex vibratory stresses, the writer developed stress gages to aid him in his experimental work. These gages and the principle on which they operate are described. The gages aid in the solving of biaxial stress equations without a second measurement or calculation. *Machine Design*, July, 1946, pages 132–136, 186, 188, 6 illus.

Fallacy of Stress Ratio Method. Victor A. Ivanoff. This article considers a trend in the progress of stress analysis identified as the "Stress Ratio" method, known also as the "Interaction Curve" method, which deals with cases of combined stress; for example, the stresses of compression, bending, and torsion. The writer states that the method is misleading and that it becomes a handicap to true progress where the science of strength of materials and stress analysis is concerned. Several formulas are reproduced and the inherent errors are explained. *American Helicopter*, July, 1946, pages 14, 27–29, 2 illus.

Torsion in Conical and Cylindrical Shells Intersected by Planes. F. W. David. Stiffened conical and cylindric shells discontinued by plane intersections not parallel to the plane of the applied torsional moment are frequently encountered in aircraft design. Examples are cockpit enclosure trays and floors in fuselages, sloping frames, and spars in wings, etc. It is stated that it is generally not correct to assume in such shells that the shear at any section is in inverse proportion to the area at that section. The exception is the case where the cross-sectional area remains proportional to the square of the width of the plane intersection. In all other cases additional bending will have to be taken either by the shell or the intersecting tray. As the skin with its variable curvature along the edge of the tray is rather more suited to transfer shear than bending, it appears more practicable to design the tray to cope with the bending loads. The writer develops a design analysis and presents general diagrams for orthogonal cylindric shells. These diagrams may also serve to assess the loads for preliminary design purposes in conical shells of small taper. *Aircraft Engineering*, June, 1946, pages 200–205, 28 illus.

Stresses in and General Instability of Monocoque Cylinders with Cutouts. Part I: Experimental Investigation of Cylinders with a Symmetric Cutout Subjected to Pure Bending. N. J. Hoff and Bruno A. Boley. Ten 24S-T Alclad cylinders of 20-in. diameter, 45- or 58-in. length, and 0.012-in. wall thickness, reinforced with 24S-T aluminum-alloy stringers and rings were tested in pure bending. In the middle of the compression side of the cylinders there was a cutout extending over 19 in. in the longitudinal direction, and over an angle of 45°, 90°, or 135° in the circumferential direction. The strain in the stringers and in the sheet covering was measured with metalectric strain gages.

The stress distribution in the cylinders deviates considerably from the linear law valid for cylinders without a cutout. The maximum strain measured was about four-thirds of the value calculated from the formula for the relationship of applied bending



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moment and moment of inertia of the cross section of the portion of the cylinder where the cutout was situated. A diagram is presented containing the strain factors defined as the ratios of measured strain to strain calculated with the formula. All the ten cylinders tested failed in general instability. One antisymmetric and two symmetric patterns of buckling were observed, and the buckling load appeared to be independent of the method of manufacture and the length of the cylinder. The buckling load of the cylinders having cutouts extending over 45°, 90°, and 135° was 66, 47, and 31 per cent, respectively, of the buckling load of the cylinder without a cutout.

Part II: Calculation of the Stresses in a Cylinder with a Symmetric Cutout. N. J. Hoff, Bruno A. Boley, and Bertram Klein. A numerical procedure is presented for the calculation of the stresses in a monocoque cylinder with a cutout. In the procedure the structure is broken up into a great many units; the forces in these units corresponding to specified distortions of the units are calculated; a set of linear equations is established expressing the equilibrium conditions of the units in the distorted state; and the simultaneous linear equations are solved. A fully worked out numerical example, corresponding to the application of a pure bending moment, gave results in good agreement with experiments carried out earlier at the Polytechnic Institute of Brooklyn. *National Advisory Committee for Aeronautics, Technical Notes Nos. 1013 and 1014*, June, 1946.

A New Theory on Load Distribution among the Rivets or Spot Welds of a Group. K. H. Swainger. Designers and laboratory workers want to know rationally the manner in which loads are distributed among the individual rivets or spot welds of groups. Increased structural efficiency, saving in weight, and better interpretation of test results would result. The few analyses available to date are restricted to lines of a few rivets in extremely narrow strips, or when an infinite number of rivets may be represented as a kind of glue layer between the plates joined. The writer proposes his method to solve (1) load distribution among a finitely large number of rivets or spot welds arranged in any pattern in a plate; (2) the effect of free edges near the rivet group; (3) stresses around any individual rivet or spot weld.

The writer's analysis for the plane stresses and displacements around a single solid expanded rivet or spot weld shows that superposition is justified. Rapidly convergent successive approximation methods displace the rivets by specified amounts. Approximately free edges are created by reflecting rivet systems about the line in the plate representing the free edge. It is concluded that (1) a free edge near a rivet and at right angles to its direction of displacement tends to lessen the rivet load for a given displacement; (2) distribution of rivets in a group may be arranged so that load is fairly evenly distributed over the members and hence lead to a considerable saving in weight in, say, aircraft engineering; (3) load and fatigue tests on groups of rivets and spot welds may be arranged more rationally since a good approximation to the stresses operating may be predicted; (4) the solutions should be good approximations to the load distribution among spot welds because in this case the plate is fully elastic although slightly upset by the welding heat; (5) as long as the rivet-hole expansion does not exceed 0.2 per cent the solutions should be good approximations for solid expanded rivets. However, since the rivets may expand about 5 per cent the large plastic field thereby induced in the plate will act as a "cushion" to reduce the peak loads. Hence, rivet groups should distribute the load better than spot welds of the same size and pattern. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1999.* British Information Services, New York, $2.15.

The Technique of Wing Resonance Tests. P. B. Walker and A. W. Clegg. The resonance tests described in this report are intended primarily to provide data for the estimation of flutter speeds, and in particular for the determination of natural wing frequencies and corresponding modes of deformation.

The tests were conducted on a complete aircraft elastically supported. Excitation was provided by a vibrator attached to the fuselage. The relatively simple apparatus required is described, together with the procedure for measuring frequencies and modes of deformation. A convenient routine is also given for the analysis of observations and for the presentation of data in the form required for subsequent estimation of flutter speed.

The method of testing described has been well tried at the Royal Aircraft Establishment on aircraft up to 20,000-lb. weight, but there are reasons to suppose that with minor adaptation it could be applied to much larger aircraft. It has also been established that similar methods are applicable to fuselage and empennage vibrations, as well as to the wing vibrations which are the main concern of this report. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 2046.* British Information Services, New York, $0.90.

Wind Tunnels and Laboratories

What Price Air Power? William Friedman. A review of present research development taking place at Wright Field includes descriptions of jet and turbojet power plants, Jato rocket units, the Lockheed Shooting Star, the Republic Thunderjet, and electronic systems for radar control of pilotless missiles. A survey of the research facilities compares the wind tunnels in existence in the United States with five types of tunnels that are planned for further development of aircraft, rockets, and remote-controlled missiles.

The first tunnel is designated as a simple air-exchanger type wind tunnel, similar to the Otztal type in Austria. The second tunnel would be designed for full-scale tests on nacelles, thermal-jet engines, propeller combinations and similar problems, at Mach Numbers up to 0.9 with varying temperatures and at simulated altitudes up to 80,000 ft. The third tunnel would serve the transsonic researchers and would be able to handle Mach Numbers from 0.7 to 1.8. With 150,000-hp. output, scavenging, evacuating, and refrigerating equipment similar to Tunnel 2, this unit's 20-ft. working section could accommodate full-scale gas turbines, jet engines, and winged missiles. Tunnel 4, as projected, would have an 8 by 12-ft. section designed to operate in the supersonic range between Mach Numbers 1 and 3. Accommodating scale airplane models, full-scale components of ram and turbojets, rocket-propelled missiles, and similar projects, this tunnel would permit tests under pressures greater than sea level, as well as high-altitude conditions. In the proposed fifth tunnel, a 40-in.-square test section would operate continuously at speeds corresponding to Mach Numbers 1 to 10, the hypersonic range.

The writer outlines the problems in jet-engine design that require closer study. The problems mentioned are heat transfer and insulation, the difficulties resulting from skin friction at high speeds, and the entire field of nuclear fission, as applied to propulsive power. The structures and materials necessary for this work are described.

Reference is made to requirements for physiologic research including pressure suits, ejection seats, ribbon-type supersonic parachutes, and test chambers for the study of effects of heat and cold, vibration, noise, odors, temperature, pressure, and other associated flight conditions. On the subject of fuels for the future, the writer states that the problems of improving current fuels, developing additional energy sources, determining standards and ratings for fuels not in common use, and planning manufacturing processes, service, storage, and handling of new fuels and propellants, demand extensive and costly research. The need is stressed for instrument development to measure properly the results of tests. The nature of the Electronic Area, the Computation Area, and the Special Test Section is described. *Air Force*, August, 1946, pages 39–44, 64, 5 illus.

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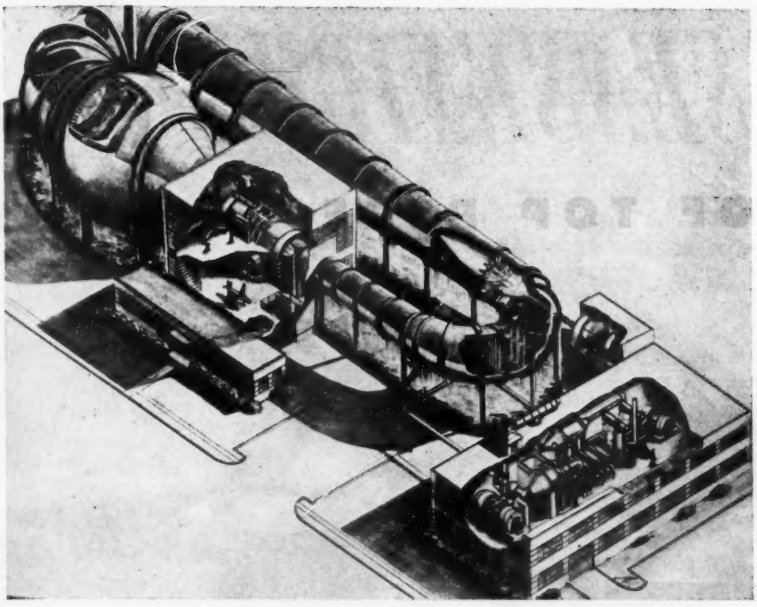

The N.A.C.A. 12-ft. low turbulence pressure tunnel.

New N.A.C.A. Transonic Wind Tunnel. The 12-ft. low-turbulence pressure wind tunnel is capable of speeds up to the speed of sound and permits scientists to secure design information applicable to full-sized, high-speed aircraft, under the most closely duplicated free-air conditions yet attained in a wind tunnel. It has been completed recently at the N.A.C.A.'s Ames Aeronautical Laboratory at Moffett Field, Calif. The test section is 12 ft. in diameter. However, by increasing the pressure of the air inside the tunnel to as high as six times atmospheric pressure, the data secured on airplane models of 10-ft. wing span are directly applicable to full-sized airplanes of 60-ft. span. The low-turbulence aspect is one of the most important features of the tunnel. Large screens housed in a sphere just ahead of the test section reduce turbulence in the wind-tunnel air stream to that existing in free flight. Inside the sphere are stretched eight fine-mesh wire screens spaced 9 in. apart, each one over 60 ft. in diameter. The air moves slowly through this section, at about only 20 m.p.h. Combined with the action of the screens is the effect of the extremely large contraction ratio of 25:1 between the large-diameter sphere and the 12-ft. test section.

Air is circulated through the tunnel by two 18-ton variable-pitch coaxial fans, which are powered by electric motors aggregating 11,000 hp. By means of large centrifugal compressors, air pressure in the tunnel can be varied from $^1/_6$ to six times atmospheric pressure. Control over the model's attitude in the air stream, and control of the tunnel as well, is concentrated at one master-control panel outside the test chamber. All balances and recording equipment are located inside a cylindric steel chamber surrounding the test section. The latter is vented to the chamber to simplify connection of support struts to the balance system. The chamber is thus under the same pressure as the inside of the test section and is sealed to the tunnel shell by a steel pressure seal.

The total weight of the tunnel is more than 4,000 tons. Because the shell is steel, it has to be allowed to move on its mountings with changes in pressure and temperature. There is only one fixed and rigid point of support, at the forward end of the test section. The rest of the tunnel floats on 52 pin-ended columns.

The problem of cooling the pressure tunnel is handled by three elements. The air is cooled during compression by water-cooling coils. Cooling after compression is accomplished by Freon refrigeration, which delivers the air to the tunnel at 40°F. In addition, a water-cooling system sprays water over the top of the tunnel to keep the shell temperature down. *National Advisory Committee for Aeronautics.*

Miscellaneous

"Marflex" Flexible Fuel Cells for Aircraft. The article gives particulars about Marflex flexible fuel cells, which were developed during the late war by Imperial Chemical Industries Limited, of London. These are constructed from neoprene-coated fabric "tailored" onto wooden forms. It is stated that they will withstand the chemical action of fuels and will retain their flexibility over a reasonably wide temperature range. Details are given about the construction of Marflex wing cells for the Tudor II. *Engineering*, June 21, 1946, pages 584, 585, 4 illus.

Ball Bushings. Ball bushings for linear motion are described in a 16-page illustrated catalog. They have been developed to provide a rolling instead of sliding contact for reciprocating shafts and thus reduce friction. Three or more oblong circuits of balls are provided, each of which has the balls in one of its straight sides in bearing contact between the inner surface of the ball-bushing sleeve and the shaft. The load is rolled freely along on the balls in this portion of the track. Balls in the remainder of the circuit are free to roll in clearance provided in the sleeve. A retainer is interposed between the sleeve and the shaft which guides the balls in their proper path and prevents them from falling out when the ball bushing is removed from the shaft. The number of ball circuits is determined by the shaft diameter. *Thomson Industries, Inc.*, Long Island City, N.Y.

A New System of Radio Telemetering

(*Continued from page 31*)

justment has to be made only once for each installation. The complete equipment except the radio transmitter and receiver is shown in Fig. 4.

Flight Tests

Complete flight tests were made of this equipment by the Aircraft Radio Laboratory at Wright Field, Dayton, Ohio. The position transmitting equipment was mounted in an AT7 aircraft and favorable results were obtained within the range of the radio equipment. It was noted that when the aircraft was flown out of the range of the radio equipment, the phase meter indicator maintained the indication at the point of losing radio contact, taking up the correct reading instantaneously again upon the re-establishment of the radio contact.

A system of this type is also applicable to multichannel instrument transmission on one-radio carrier. For this use, one comparison signal is employed with a multiplicity of intelligence waves, enabling a compact and accurate system for transmitting the entire flight group of instruments.

For industrial telemetering, the radio link may be eliminated, enabling an accurate and flexible multi- or single-channel telemetering adaptable to carrier current or wire service.

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Books

Machine Design

V. L. Maleev

Recent research work devoted to the properties and special characteristics of engineering materials and to the influence of loads and other working conditions on the stresses set up in machine parts has made available important information with regard to such phenomena as stress distribution, stress concentration, endurance of materials, creep, and others. In this text, which is a revised edition, the material has been assembled and its application to design is illustrated. The author has attempted to eliminate the inconsistency between Hooke's law—the basis of machine design—and the usual assumptions that the elastic stresses in a machine part can be neglected.

The second chapter deals with the theories of stresses in machine parts, giving the appropriate tables and formulas. The third chapter sets forth the properties of materials and gives a basis for design calculation in the form of tables and diagrams containing experimental data, with particular regard to the elastic and endurance limits of various engineering materials. The chapter on machine design calculations departs from the usual treatment in its definition of the safety factor. Other chapters contain discussions of the fundamental mechanical devices that are incorporated in machines and are used for the transmission and control of power. Appendixes contain problems related to the different chapters and a treatment of the rational design of ribs. International Textbook Company, Scranton, Pa., 1946; 581 pages, $4.50.

Aircraft Drafting

Hyman H. Katz

A design engineer who supervised the training of draftsmen for large aircraft companies has prepared a text and reference book for students and draftsmen who desire to enter the engineering branch of the aircraft industry. In addition to teaching basic engineering drawing techniques, it explains the fundamentals of aircraft design, the engineering procedures now used in the aircraft industry, and the particular problems, methods, and materials of aircraft production with which the draftsman should be familiar.

The fundamentals are defined in easily understood language and are applied directly to aircraft design. Graphic description, with carefully designed illustrations, is used in place of detailed explanations wherever possible. Orthographic projection is presented in color to facilitate rapid comprehension of basic mechanical drawing. Pictorial drawing is stressed. Lofting technique, procedure, and practice are explained in detail, and information is given about change groups, bills of materials, and weight calculations. Useful design data are included. Problems follow many of the chapters to illustrate the points discussed in the text. The Macmillan Company, New York, 1946; 386 pages, $5.00.

Soaring Flight

Terence Horsley

The author, an experienced British glider pilot, combines a technical understanding of his subject with the ability to describe gliding and soaring for those who have not explored the updrafts, downdrafts, and other natural phenomena of the sky in engineless craft. The meteorologic factors encountered in soaring are studied in detail, accompanied by explanatory diagrams and photographs. Although the book deals largely with soaring and gliding as a sport and means of recreation, those interested in aerodynamics and related sciences will find a considerable amount of technical information, especially in the chapters about the aircraft and the forces that act upon it, instruments and control equipment, and flight techniques.

The accomplishments in this field by other countries, both for military purposes and for pleasure, as well as the future of soaring in the United States, are discussed. This book is said to be the first on nonpowered flight devoted specifically to soaring. The 42 pages of photographs show the cloud formations that affect gliding, different types of gliders and sailplanes on the ground and in flight, and various launching devices. Numerous sketches clarify the technical descriptions. Appendixes contain a history of gliding in the United States, brief descriptions of American engineless aircraft, lists of American gliding clubs and soaring sites, rules and standards, and current flight records. Current Books, Inc.—A. A. Wyn, New York, 1946; 326 pages, $4.00.

Book Notes

Use of Tools, (NAVPERS 10623) prepared by Standards and Curriculum Division Training, Bureau of Naval Personnel; Government Printing Office, Washington, D.C., 1945; 258 pages, $0.45.

One of the booklets prepared for the Basic Training Courses is a manual for enlisted men of the Navy whose duties require them to use tools to keep Navy gear and equipment in good condition. The text matter is arranged in groups according to the kind of work the tools are designed to perform. It begins with advice on the handling of such general-purpose tools as hammers, screw drivers, punches, and wrenches, and explains the use of tools for cutting and shaping metal. Other chapters are devoted to tools for threading; pipe and tubing tools; woodworking tools, measuring tools, gages, and indicators; soldering and welding tools; and metal-fastening devices and abrasives.

Deep Drawing and Pressing of Aluminium Alloys; Aluminium Development Association, London, 1946; 40 pages.

This Information Bulletin No. 10 describes the forming of wrought aluminum alloys by blanking, shearing, punching, perforating, deep drawing, pressing, folding, bending, flanging, coining, and embossing. Appendixes contain an abstract from a paper on the effect of shape on the formability of deep-drawn sheet-metal parts and a bibliography.

A Chronological History of Electrical Development from 600 B.C.; National Electrical Manufacturers Association, New York, 1946; 106 pages, $2.00.

The history of electricity from 600 B.C. to 1944 is presented in outline form. The book provides a picture of the development and growth of electrical science and the electrical manufacturing industry. An appendix contains a list of member companies of the National Electrical Manufacturing Association, with historical data about each of them.

The Long Way Home, by Sgt. Millard Lampell; Julian Messner, Inc., New York, 1946; 174 pages, $2.50.

A collection of scripts which were first produced over an official A.A.F. radio program titled "First in the Air," under the direction of the author. The book is a story of the soldier's homecoming and his fight for some kind of decent, secure world to live in.

Instruments for Measuring Atmospheric Factors Related to Ice Formation on Airplanes, by B. Vonnegut, R. M. Cunningham, and R. E. Katz; Department of Meteorology, Massachusetts Institute of Technology, Cambridge, Mass., 1946; 103 pages.

For the past 2 years the De-Icing Laboratory of the Massachusetts Institute of Technology has been concerned with the development of instruments for measuring atmospheric factors related to ice formation on aircraft. This booklet describes the instruments produced as a result of the research work. In an introduction to the subject the nature of icing conditions is summarized. Particulars then are given about rotary cylinder instruments, drop size, measurement apparatus, a rotating magnetic disc icing-rate meter, a capillary collector, electric water-collection rate meter, and anti-icing heat meter. Sections also are devoted to spray tunnels and meteorologic aspects of ice formation.

Aerodynamics Analysed, by T. E. G. Bowden; Harborough Publishing Company Limited, Leicester, England, 1943; 63 pages, 2*s*.

Questions frequently asked by students of elementary aerodynamics are answered in this booklet, which provides explanations in easily understood language. Sections are devoted to the atmosphere, the airfoil and airflow, wind tunnels and measuring apparatus, stability and equilibrium, control and maneuver, the propeller, and performance.

The ABC of Practical Astro-Navigation, by R. K. Vandervord; Sir Isaac Pitman & Sons, Ltd., London, 1946; 55 pages, 6*s*.

A handbook containing explanations of fundamental principles of celestial air navigation and supplemented by problems, questions and answers, and diagrams has been designed to enable the student to master the essential principles underlying the subject in the shortest possible time. Solving these problems is intended to aid the beginner to acquire a knowledge of procedure prior to actual practice in the air. The author's object has been to provide, to the extent possible in a book, the practice necessary to make the mathematical calculations a matter of habit and routine.

American Standards Association 1945–46 Year Book; American Standards Association, New York, 1946; 112 pages.

The 1945–1946 yearbook of the American Standards Association is the first that has been published for several years. It contains much new material. The main section of the book is devoted to a listing of approved American Standards and projects under development, together with the names of officers and members of active technical committees.

The Model Aeronautical Digest, 1944, by R. Copland and R. H. Warring; Model Publications, Ltd., Surrey, England, 1944; 160 pages, 5*s*.

Information about the design, construction, and operation of model airplanes is presented in this digest, which is the work of eight experienced British model builders. Plans of 32 outstanding model airplanes are included. Particulars are supplied about the design of airfoil sections, propellers, rubber and gas models, sailplanes, and seaplanes.

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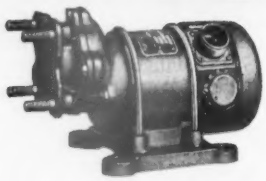

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I.A.S. Meeting Preprints

A limited number of copies of preprints of papers presented at meetings of the Institute are available for distribution, at a charge of 25 cents each to members of the Institute, and 50 cents to non-members, to cover handling and mailing charges. The following lists preprints available from the past four national meetings of the Institute. Preprints may be ordered by number.

Fourteenth Annual Meeting—New York, N.Y., January 29–30–31, 1946

1. The Reduction of Flight Test Performance Data to Standard Air Conditions by the Temperature Altitude Method—J. G. Beerer, Assistant Chief Technical Engineer, North American Aviation, Inc. 34 pages; 9 illus. (Ditto.)
2. Higher Modes of Vibration by a Method of Sweeping—L. Beskin, Design Specialist, Consolidated Vultee Aircraft Corporation, and R. M. Rosenberg, Consulting Engineer, Purdue University. 38 pages; 7 illus. (Ditto.)
3. The Determination of Airspeed System Errors—Herbert R. Crawford, Chief Flight Test Engineer, Grumman Aircraft Engineering Corporation. 68 pages; 13 illus. (Typewritten and photo-offset.)
4. Trouble Shooting with Vibration Equipment—Harold Vern Hawkins, Vibration Engineer, Bell Aircraft Corporation. 37 pages; 13 illus. (Typewritten and photo-offset.)
5. The Development of a High-Temperature Light-Weight Insulation for Jet Aircraft—Donald Jelinek, Mechanical Research Engineer, North American Aviation, Inc. 26 pages; 22 illus. (Ditto.)
6. Safety Beyond Regulatory Requirements—W. E. Koneczny, Safety Bureau, Civil Aeronautics Board. 25 pages; no illus. (Mimeographed.)
7. Force Measurements by Means of Resistance Wire Strain Gages—W. C. Randels, Aeronautical Engineer, North American Aviation, Inc. 7 pages; 7 illus. (Typewritten and photo-offset.)
8. Considerations in the Design of a Low Cost Wind Tunnel—Howard E. Roberts, Aerodynamics Engineer, Douglas Aircraft Company, Inc. 46 pages; 12 illus. (Typewritten and photo-offset.)
9. Hydraulic Motors and Their Application to Aircraft—James Robinson, Assistant Chief Engineer, Vickers Incorporated. 4 pages; 6 illus. (Vari-typed and photo-offset.)
10. Systematic Wing Section Development—George S. Schairer, Chief Aerodynamicist, Boeing Aircraft Company. 14 pages; 14 illus. (Mimeographed with photostats of illustrations.)
11. Measurement of Steady and Vibratory Stresses in Aircraft Propellers—E. F. Shelley, Project Engineer, Propeller Division, Curtiss-Wright Corporation. 8 pages; 9 illus. (Mimeographed with ditto illustrations.)
13. The Organization and Utilization of an Aircraft Manufacturer's Air Safety Program—Amos L. Wood, Chief, Accident and Operations Analysis, Boeing Aircraft Company. 9 pages; 14 illus. (Mimeographed with photostats of illustrations.)

Aircraft Propulsion Meeting—Cleveland, Ohio, March 21, 1946

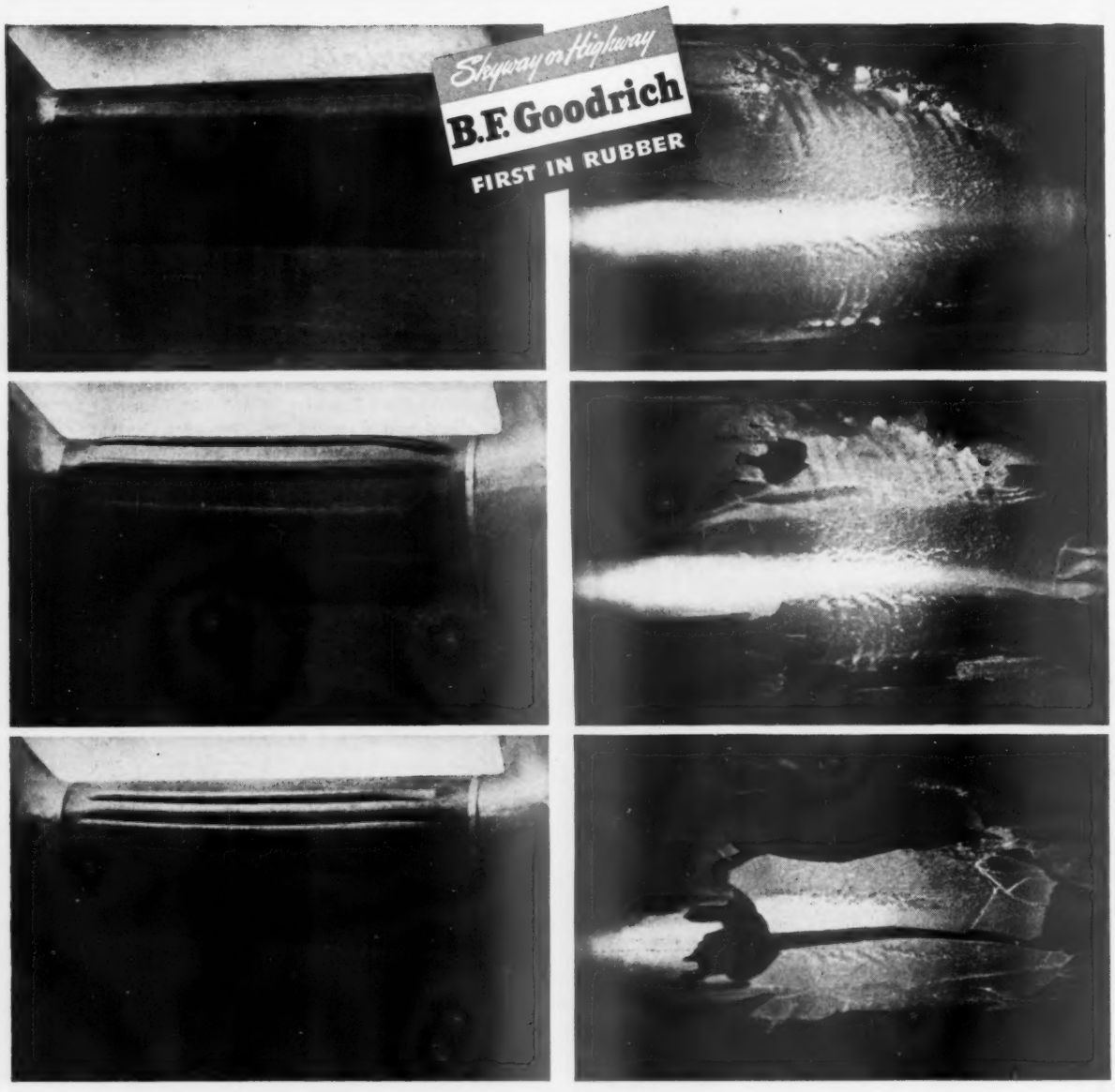
15. Application of Axial Compressors in Aeronautics—Ens. F. J. Gardiner, United States Naval Reserve, Navy Department, Bureau of Aeronautics. 11 pages; 8 illus. (Typewritten and photo-offset.)

Light Aircraft Meeting—Detroit, Mich., June 13–14, 1946

16. Effect of Center of Gravity Movement on Safety of Personal Aircraft—J. M. Gwinn, Jr., Chief Engineer, Personal Aircraft Engineering, Consolidated Vultee Aircraft Corporation. 12 pages; 5 illus. (Mimeographed.)
17. Optimum Seating Arrangements for Light Airplanes—Frederick K. Teichmann, Professor of Aeronautical Engineering, Chairman, Department of Aeronautics, Daniel Guggenheim School of Aeronautics, New York University. 7 pages; no illus. (Mimeographed.)
18. Maintenance of Personal Aircraft—George H. Weitz, Chief, Air Frame Section, Non-Scheduled Aircraft Maintenance Division, Civil Aeronautics Administration. 7 pages; no illus. (Mimeographed.)

Annual Summer Meeting—Los Angeles, Calif., July 18–19, 1946

19. Flying Qualities Requirements for Military Aircraft—Lt. Malcolm J. Abzug (j.g.), United States Naval Reserve, Flying Qualities Specialist, Aerodynamics and Hydrodynamics Branch, Bureau of Aeronautics. 16 pages; 3 illus. (Vari-typed and photo-offset.)
20. Engineering Aspects of the Development of the Rainbow—Alexander Kartveli, Vice-President and Chief Engineer, Republic Aviation Corporation. 68 pages; 61 illus. (Vari-typed and photo-offset.)
23. Current Problems in Developing Major Components for Aviation Gas Turbines—Arnold H. Redding, Section Engineer, Flow Research Development and Research Engineering, Westinghouse Electric Company. 19 pages; no illus. (Mimeographed.)
24. A Concept of Jet Aircraft Utilizing Boundary Layer Air for Propulsion—A. M. O. Smith, Preliminary Design Aerodynamicist, and Howard E. Roberts, Aerodynamic Engineer, El Segundo Engineering Division, Douglas Aircraft Company, Inc. 44 pages; 17 illus. (Photo-offset.)
25. Design and Development of the Douglas B-42—Carlos C. Wood, Head of Preliminary Design, Santa Monica Engineering Division, Douglas Aircraft Company, Inc. 9 pages; 21 illus. (Photo-offset.)



Here goes the De-Icer... there goes the ice

YOU'RE watching a B. F. Goodrich De-Icer at work. The pictures on the left show what happens under the ice that's being removed from a wing. Pictures on the right show what happens to the ice.

Chances are you've demonstrated the De-Icer principle when you took ice cubes from a rubber refrigerator ice-tray. When the ice-tray was flexed, the ice cubes cracked loose from the rubber and were easily removed. De-Icers are long rubber and fabric strips with tubes inside. Tubes are inflated and deflated, flexing the rubber, cracking the ice. The windstream carries it away, as it is about to do in the bottom right-hand picture.

The B. F. Goodrich De-Icer has many advantages that make it the best ice-elimination device ever developed for aircraft. De-Icers protect *all critical areas*. They afford full spanwise and chordwise coverage of wing and tail leading edges . . . where most ice forms. Weight is minimized. De-Icers represent only a fractional percentage of a commercial plane's gross weight, and this is negligible, considering the protection afforded plane and passengers.

De-Icers are still the object of study and research by B. F. Goodrich laboratory and field technicians to keep designs and types abreast of flight and plane developments. *The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.*

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FIRST IN RUBBER

Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Mechanical Engineers, Designers and Layout Draftsmen—Having a minimum of 3 years' industrial experience on small electromechanical devices. Positions are in the Engineering Division of the makers of the Link Trainer. Engineering degrees or equivalent are required for engineering and designing positions. Forty-hour week allows leisure to enjoy area's many outdoor activities. Wages paid are equal to, or above, locality average. Send all particulars to Personnel Manager, Link Aviation Devices, Binghamton, N.Y.

Aeronautical Engineers—The Board of U.S. Civil Service Examiners, U.S. Naval Air Station, Quonset Point, R.I., announces that a limited number of applications are now being accepted for the position of Aeronautical Engineer (Power Plants), P-3, $4,149.60 per year. Applicants must show that they have successfully completed a full 4-year course leading to a Bachelors' Degree in Aeronautical Engineering in a college or university of recognized standing; or 4 years of successful progressive aeronautical engineering experience. In addition, applicants must show 3 years of progressive professional aeronautical engineering experience involving aircraft power plants. Graduate study in aeronautical engineering involving aircraft power plants successfully completed in a college or university of recognized standing may be substituted for experience year for year, up to a maximum of 3 years. Applicants applying for this position should mail Standard Civil Service Form 57 to: Recorder, Boardof U.S. Civil Service Examiners, U.S. Naval Air Station, Quonset Point, R.I.

Research Engineer—Responsible position open with small corporation engaged in development engineering on aircraft instrumentation and control systems. Background of mechanical engineering or applied physics required. Address inquiries to Box 388, Richmond, Va.

Engineers and Physicists—Advanced positions are open to high-type engineers and physicists with master's or doctor's degrees to perform research, development, and design studies relating to high-speed aircraft and missiles. Salaries commensurate with ability. Excellent working conditions. Address inquiries to R. C. Blaylock, Chief Engineer, Curtiss-Wright Corporation, Airplane Division, Columbus 16, Ohio.

Engineers, Technicians—The National Advisory Committee for Aeronautics at Langley Field, Va., has openings for engineers and technicians to work on the design, development, and application of instruments for use in its wind tunnels and other aeronautical research facilities. Currently, a large portion of the instrumentation is devoted to speeds considerably greater than the speed of sound and to the development of pilotless aircraft and guided missiles. There are openings for professional men ranging from a starting rate of $2,644.80 per annum for men just out of college to $4,902 per annum for men with experience in instrument work. There are also openings for instrument mechanics and instrument makers, ranging from $2,034 per annum for men who have had a minimum of 2 years of experience, other than routine production, in construction, test, installation, or maintenance of mechanical, electrical, electronic, or optical instruments to a $3,090 per annum starting rate for first-class journeymen. Apply to Instrument Research Division, National Advisory Committee for Aeronautics, Langley Field, Va.

Aeronautical Engineers—To participate in design and development program of new aircraft in Engineering Branch. Immediate openings for aerodynamicists, flight test engineers, power plant engineer, design draftsmen. Address inquiries to Edo Aircraft Corporation, College Point, N.Y., Attention of Mr. C. J. Libby, Administrative Engineer.

Graduate Aeronautical Engineer—Small expanding engineering and manufacturing organization located in Houston, Tex., has a job opportunity for a recent engineering graduate interested in the design and/or manufacture of personal airplanes. Write giving complete pertinent information, including interests, experience, and starting salary expected to Anderson, Greenwood and Company, Sam Houston Airport, Houston, Tex.

Engineering Personnel—Engineers with 5 or more years of helicopter experience in any one of the following lines: aerodynamics, stress analysis, vibration analysis, project engineering, and engineering flight test. Apply by letter to United Helicopters, 625 El Camino Real, Palo Alto, Calif.

Heating and Ventilating Engineer—Senior heating and ventilating engineer, familiar with the principles of heat exchange and air conditioning applicable to aircraft design, is required to act as Group Leader in the Design Office of a large aircraft manufacturing company in Montreal. Candidates should be graduate electrical, mechanical, or aeronautical engineers and should have at least 5 years' experience, including 3 years' specifically in the above work, and 1 year of supervisory experience. Applicants should write giving details of educational background, experience, salary expected, and availability to Canadair Limited, P.O. Box 6087, Montreal, Quebec, Canada.

Mechanics—Line Maintenance—Forty hours (rotating shifts). $1.26 per hour with periodic increases. Four years' minimum experience in multi-engined aircraft (C-54 experience desirable). Preference given for experience in electrical or instrument line maintenance and Aircraft and Engine Licenses. Contact Personnel Department, American Overseas Airlines, LaGuardia Field, N.Y.

Mechanics—Foreign Service: Paris, Iceland, Azores, Greenland. Foreman, $325 per month; lead mechanics, $325 per month; mechanics, $262.50 per month; $175 in addition to monthly salary for overseas duty. One year C-54 experience minimum, with an additional 3 years' experience in line maintenance, and Aircraft and Engine Licenses. Contact Personnel Department, American Overseas Airlines, LaGuardia Field, N.Y.

Instructor—Wanted by Department of Mechanical Engineering beginning in the fall quarter to teach undergraduate courses in aeronautics and courses in heat power engineering. Must have good academic training and some teaching experience; should have practical experience in aeronautical engineering and ability to do research. Salary up to $4,500 based on training and experience. Apply to Department of Mechanical Engineering, College of Engineering, University of Kentucky, Lexington 29, Ky.

Aeronautical Engineers—Group Engineers in stress, structural test, and aerodynamics; lead and major engineers in design, aerodynamics, stress analysis, and structural test wanted immediately for development and production engineering work on feeder-line airplane (Boeing 417) and military aircraft. Write Chief Administrative Engineer, Boeing Airplane Company, Wichita Division, Wichita, Kan.

Aeronautical Engineers—Qualified Engineers are urgently needed for development work on flight test instrumentation at Wright Field, Dayton. Attractive positions are open for research engineers (electrical, electronic, aeronautical, mechanical) with previous industrial experience in aircraft instrument development. Salaries range from $2,644 to $7,102 with the additional benefits of Federal Civil Service. Applicants may submit Civil Service Form No. 57 (obtained at local Post Office) to Secretary, Civil Service Board of Examiners, Air Matériel Command, Wright Field, Dayton, Ohio. Attention: TSFIS.

Research Designer—Airplane designer, with previous experience in applied mechanics, aerodynamics and stress analysis, to lead aircraft and missile design group. Advanced degree desirable. Thorough knowledge of jet propulsion necessary. Replies will be held in strict confidence. Write Cornell Aeronautical Laboratory, Employment Office, Buffalo 5, N.Y.

Thermodynamicist—With strong theoretical background to engage in research work in the field of jet propulsion. Advanced degrees preferred. Replies will be held in strict confidence. Write Cornell Aeronautical Laboratory, Employment Office, Buffalo 5, N.Y.

Aeronautical Engineers—The U.S. Naval Air Station, Jacksonville, Fla., requires the services of several highly qualified aeronautical engineers with power-plant or structures background, and preferably with some production experience. Salaries range from $2,980 to $5,180 per annum. Applications are now being accepted. Interested persons may obtain Civil Service Application Form 57 from their local post office and forward, completely filled out, to the Recorder, Industrial Relations Department, U.S. Naval Air Station, Jacksonville, Fla.

Aeronautical Engineers—Excellent opportunities for graduate engineers in design, stress analysis, or layout now exist for personnel interested in working on commercial-type aircraft. Write, giving education and experience, to the Personnel Department, Cessna Aircraft Company, Wichita 1, Kan.

Engineers—The Army Air Forces Air Institute of Technology being established at the Air Matériel Command, Wright Field, Dayton, has several openings for qualified professors and engineers to administer and to teach on a graduate and undergraduate level in the College of Engineering (Aeronautics). Starting salary ranges from $4,300 to $7,175, depending on position and qualifications. Employment will be effected in accordance with provisions in Civil Service Regulations. As faculty member, applicant should be capable of expanding into a research and consulting relationship with the various A.M.C. Engineering Division Laboratories. Write Commanding General, Air Matériel Command, Wright Field, Dayton, Ohio, Attention TSPCP-1, setting forth personal data and qualifications, education and experience; or forward Civil Service Form 57, available at post office.

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For INDUSTRIAL and AERONAUTICAL USE

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Weight: 5 lbs.

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b) Two separate "4-Way" selector valves
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May be used with power-driven pump, using hand-pump as an auxilliary.

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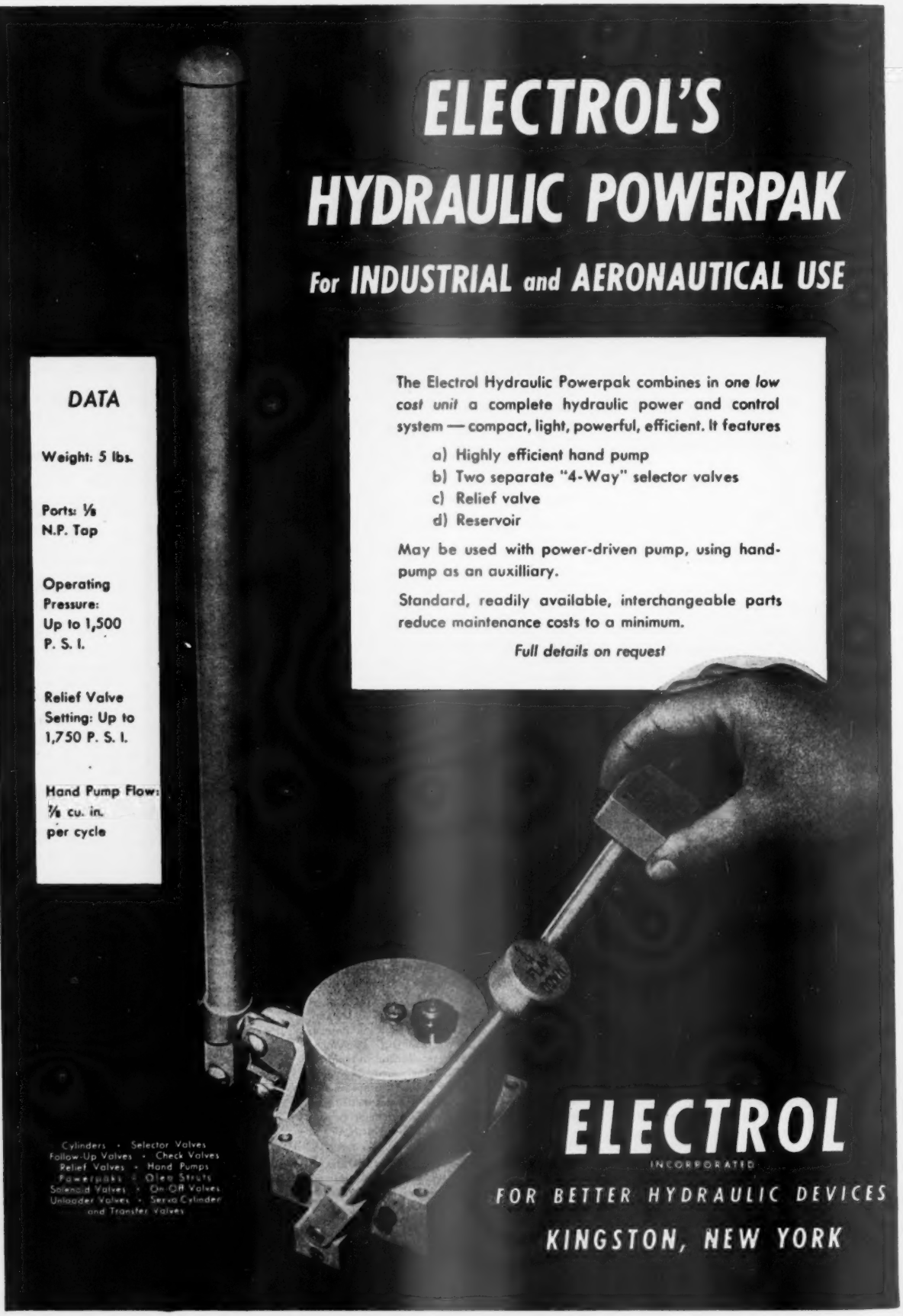

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Aeronautical Engineers—Thoroughly trained, experienced, and qualified to deal with problems in aerodynamics and thermodynamics. Opportunity to participate in development work arising from the application of advanced types of airplane power plant and resulting high-speed performance. Write giving education and experience, to the Industrial Relations Department, Consolidated Vultee Aircraft Corporation, Vultee Field Division, 842 South Lakewood Blvd., Downey, Calif.

Aerodynamicists—Immediate work is available for three qualified engineers with Kaiser Fleetwings, Inc. First man must be a stability and control specialist with at least 2 years' experience, some experience with problems related to flight at transonic and supersonic speed. Second man must be a specialist in aircraft performance estimation with a minimum of 2 years' experience, familiar with compressibility phenomena and with means of accounting for these phenomena in performance estimation. Third man must be familiar with general aerodynamics work and possess some knowledge of the characteristics of ram jet, pulse jet, and rocket jet engines. Good background in thermodynamics is necessary. Address reply to G. G. Cudhea, Chief Engineer, Kaiser Fleetwings, Inc., Bristol, Pa.

Transmission Engineer—Long-established aircraft manufacturer engaged in helicopter development requires services of mechanical designer on gear transmission work. In staff specialist capacity, position offers unusual opportunities. Aircraft experience desirable but not required. Kellett Aircraft Corporation, North Wales (Philadelphia), Pa.

Assistant Professor—To teach applied mechanics, strength of materials, and fluid mechanics. A young man with M.S. degree preferred. Applicant should have special qualifications in the field of hydraulics and fluid mechanics. Opportunity to work in fluid meters research and the development of a fluid mechanics laboratory. Address inquiries to Department of Mechanics, University of Oklahoma, Norman, Okla.

Instructor in Aeronautical Engineering—To teach courses in general aeronautics and stress sections. Must have aeronautical engineering degree. Opportunity to do graduate work. Appointment for September 15, 1946. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis, Minn.

Assistant or Associate Professor—To conduct senior and graduate courses in airplane stress and design group. Must have M.S. degree in Aeronautical Engineering and experience in industry or teaching. Appointment for September 15, 1946. Salary open. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis, Minn.

Aerodynamicists—College graduates with sound theoretical training and at least 1 year of graduate study in compressible subsonic flow and supersonic flow to do research and test work in the Supersonic Wind Tunnel of the Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland. This is by far the largest operating supersonic wind tunnel in the country. Remuneration in accordance with qualifications. Write, giving education and experience, to The Commanding General, Aberdeen Proving Ground, Maryland, Attention: Director, Ballistic Research Laboratories.

Technical Representatives—To perform industrial representation within their resident state, county, or city for manufacturers and associated concerns throughout the country. Must have permanent position with an established company and complete domestic and technical information. Address inquiries to George E. Harris Associates, Rooms 314–318, Administrative Building, Municipal Airport, Wichita, Kan., Attention: G. E. Harris.

Research Engineer—Theoretical Aerodynamicist or Thermodynamicist with advanced degree to engage in research on certain high-speed developments. For details write Box 1-T, Richmond 2, Va.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

Design Engineers; Draftsmen—Opportunities now exist for qualified design engineers and draftsmen for work on the new Stratocruiser C-97 military transport and other new developments. Here is an opportunity to become associated with one of the world's leaders in aircraft design and production and to participate in the design of the aircraft of tomorrow. Write to the Engineering Department, Boeing Aircraft Company, Seattle 14, Wash.

Aerodynamicists and Thermodynamicists—Research minded and with good theoretical background, to engage in research work on high-speed and jet propulsion developments, advanced degrees preferred. Salary commensurate to qualifications. Replies will be held in strict confidence. Write, giving education and experience, to Cornell Aeronautical Laboratory, Buffalo 5, N.Y.

Aircraft Engineers—Immediate, permanent openings for aircraft engineers with 5 years' experience in aerodynamics, structural design, and C.A.A. airworthiness requirements with Southern California aircraft manufacturer. Air-mail qualifications and recent photo to P.O. Box 29, Burbank, Calif.

Radio, Electronic and Telephone Engineers, Electronic and Mechanical Draftsmen—One of the largest manufacturers of a wide variety of electronic and communications equipment in the world is fully prepared and ready with an ambitious postwar program. Write to Personnel Manager, Federal Telephone & Radio Corp., 591 Broad Street, Newark, N.J.

Aircraft Stress Engineers thoroughly familiar with the analysis of aircraft structures, aircraft controls, and all component parts for work on helicopters. Excellent opportunities for personnel interested in rotary-wing aircraft. Apply by letter, giving references, to Administrative Engineer, Kellett Aircraft Corporation, Plant #2, Lansdowne Avenue above State Road. Upper Darby, Pa.

571. Executive Engineer—Established West Coast helicopter company offers unusual opportunity for highly qualified engineer. Responsible for administration, programming, and control of engineering. In addition to technical training and experience, must have administrative and organizing ability and knowledge of production and procurement problems. Write full qualifications.

568. Personnel—An expanding southern New England helicopter company has positions available in several fields for personnel interested in rotary wing aircraft. Experience in helicopters is desired but not necessary. Give full education and experience.

567. Engineers—One of the largest engine companies located in Midwest engaged in extensive and continuing development program on nonrotating aircraft propulsion engines has openings for the following personnel:

Development Engineer—An idea man with good theoretical and practical background to direct activities of engineering group devoted to preliminary design and analysis.

Thermodynamicist — Research - minded with good theoretical background, advanced degrees preferred.

Vibrations and Structures Engineer—A man with aircraft and aircraft engine design experience, with an interest in analytical vibration problems.

Instrumentation Engineer—A man with a good understanding of wind-tunnel instrumentation, familiar with electronic, optical, and other instrumentation means suitable for use in studying aerodynamic and thermodynamic problems.

Mechanical or Aeronautical Engineers—Up to 5 years' experience, interested in research and development activity in a rapidly expanding program.

Aerodynamicist.
Physicist.

562. Assistant Professor—To teach courses in aerodynamics and aircraft structures at Eastern university. Applicant should have a graduate degree in aeronautical engineering. Salary $4,000 for 10 months.

555. Assistant, Associate, or Professor of Aerodynamics—To teach graduate courses in aerodynamics, especially aerodynamics of gas turbines, at well-known eastern school. Opportunity to engage in research. Advanced degree required and research experience preferred.

554. Aerodynamicists and Aeronautical Engineers—Positions available for highly qualified technical personnel with good theoretical background to engage in development and test work in stability and control, high-speed aerodynamics, and axial-flow compressors. Salary in accordance with qualifications. In reply please give brief summary of personal qualifications, education, and experience. As required by the Civil Service regulations now in effect, preference in appointments to these positions will be given in the following order: (1) persons entitled to ten-point military preference, (2) persons entitled to five-point military preference, (3) former Federal employees, (4) persons who do not come under (1), (2), or (3).

550. Engineer—Qualified engineer capable of serving as liaison between development engineering and factory production in aircraft electronics and related fields. Background of shop practice essential to assist and guide design engineering in production methods. Unusual opportunity for permanent position.

548. General Manager—For large and active aircraft concern located in the East. In addition to proved administrative ability and all other qualities suited to a general manager must have many years of successful aircraft production experience. Good position for a good man. State qualifications. Correspondence will be kept confidential.

538. Engineers—Experienced engineers wanted for project engineering and design evaluation work on pilotless aircraft. Aeronautical graduates with training or experience in electronics preferred. Location Washington, D.C.

534. Draftsmen—Personal plane manufacturer and government contractor located in New York Metropolitan area is seeking qualified airplane draftsmen. Engineering degree not necessary although aeronautical experience desirable.

529. Service Manager—For major personal plane manufacturer located in New York Metropolitan Area. Good opportunity.

527. Aeronautical Engineers—Immediate positions open in Washington, D.C., for aircraft engineers with practical experience in preliminary investigations of new aircraft designs and airplane performance. Salary between $3,640 and $4,300 per year. In applying please give brief sketch of personal qualifications, education, and experience.

526. Aeronautical Engineer—Position open in Washington, D.C., for aerodynamicist with design and research experience in stability and control and high-speed aerodynamics. Salary between $4,300 and $5,180 per year. In applying please give brief sketch of personal qualifications, education, and experience.

518. Power-Plant Design Engineer—For supervision of design of power-plant installations. Will also supervise design of mechanical equipment, including heating and ventilating equipment, hydraulic, vacuum, and oxygen systems and cabin supercharging systems in airplanes. Must have mechanical or aeronautical engineering degree with over 7 years' experience in this work

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Address_____

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in aircraft industry. Position available in Midwest airplane company.

512. Assistant Professor of Aeronautical Engineering—To teach courses in aircraft design and aircraft structures in aeronautical engineering department of large university in Southwest. Opportunities for research in structures and in newly organized Navy Ordnance program provide for full year-round employment. Applicants should submit detailed record of education and experience.

511. Aeronautical Engineers—To teach mathematics, primary and advanced aeronautical engineering subjects including design and stress analysis in a Midwestern university.

498. Project Engineer, Chief of Structures—Excellent opportunity for qualified men with a manufacturer of medium sized aircraft. Commercial experience preferred but not necesary.

490. Assistant or Associate Professor—Sought by Aeronautics Department of Engineering College to teach undergraduate and graduate courses in aerodynamics, aircraft structures, or aircraft propulsion. Must have good academic training and teaching experience; constructive interest in aeronautical research and development, preferably industrial or laboratory experience in this field. Starting salary range: $3,000 to $5,000, depending upon qualifications.

477. Instructor—In department of mechanical engineering to teach mainly aerodynamics, aeronautical design, and develop aeronautical laboratory. Advanced degree desired. Appointment September as Instructor or Assistant Professor, dependent on qualifications. Location Philadelphia.

466. AeronauticalEngineers—Prominent light plane manufacturer located in New York area seeking qualified aeronautical engineers including aerodynamicists, stress analysts, loftsmen and draftsmen, particularly those experienced in molded plywood and sheet metal structures. Military and civil contracts.

463. Assistant Chief Aircraft Designer—Good background and experience in civil aircraft and conversant with C.A.A. requirements. Permanent position with aircraft manufacturer in central eastern coast area. Reply by letter giving particulars as to experience, salary desired, and date available.

462. Chief Stressman with C.A.A. requirements experience, and **One or Two Assistants,** to take charge new project. Permanent position with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position.

461. Layout and Detail Draftsmen, Senior and Junior—Required for progressive aircraft program with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position.

460. Aircraft Design Engineers—Immediate permanent openings for design engineers with good experience in aerodynamics, structural design and C.A.A. airworthiness requirements with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position.

448. Aeronautical Engineers—Immediate positions open in Washington, D.C., for aircraft engineers with practical experience in structural design and research. Salary between $3,640–$5,180 per year. In applying please give brief sketch of personal qualifications, education, and experience.

443. Stress Analyst—Engineer with experience in design of rotary wing aircraft rotor blades. Must have thorough knowledge of rotor blade stress and aerodynamic analysis procedure, experimental procedure for determination of static and dynamic stresses and fatigue research methods. Permanent position involving study of wood, metal, and plastic blades.

442. Assistant Professor of Aeronautical Engineering—Must have experience in structural analysis and design. Permanent position. Applicants should furnish details describing education, experience, and personal data. College located in Virginia.

434. Assistant Professor—To conduct senior and graduate courses, develop laboratory, and direct research in aircraft power plants, with emphasis on standard aircraft engines and accessories. Advanced degree preferred. Position with an established aeronautical engineering department of a large eastern university. Appointment September, 1946. Salary open.

414. Aircraft Layout Draftsmen—Familiar with layout and design of aircraft sheet metal structures, controls, mechanisms, power plant, electrical systems and equipment. Excellent opportunities for experienced personnel interested in helicopter design.

413. Assistant or Associate Professor—To conduct undergraduate and graduate work in theory, design, and research in propellers and jet and rocket propulsion systems. Applicant should have at least one graduate degree and a sound theoretic and applied background in the thermodynamics and aerodynamics of propulsion systems. Large midwestern university.

370. Project Engineer—Experienced and talented design man to undertake the responsibility for a new aircraft project from inception to completion. Plant located on eastern seaboard. Salary scale above average. Write full particulars.

AVAILABLE

Engineer—B.S. in M.E., Ae.E.; desires responsible executive position, preferably with personal plane manufacturer. Has 20 years' design, production, and executive experience which merited brief biography in *Who's Who in America*. Address inquiries to P.O. Box 503, Mt. Vernon, N.Y.

577. Sales Engineer—Graduate aeronautical engineer with 2½ years' experience in aircraft design engineering, including liaison, desires a position as sales engineer. No objection to foreign service.

576. Aeronautical Engineer—B.Ae.E. Age 26; married. Six years' experience. Group leader and project engineer for past 4½ years. Has done basic jet research and complete helicopter design. Desires position with responsibility in New York area.

575. Aeronautical Engineer—Six years' diversified experience, including aircraft inspection, teaching, original research and development work. Familiar with stability and control problems and latest aspects of supersonic aerodynamics. Some graduate work. Will consider responsible position as project engineer or administrative assistant with progressive organization.

574. Aeronautical Engineer—B.A.E.; age 27. Three years' experience in layout, design, stress analysis, static test, shop liaison, and quality salvage with a leading aircraft manufacturer. One year at a Naval Air Station as Engineering Officer in the Assembly and Repair Department. Desires a responsible position in production management. East Coast preferred.

573. Aeronautical Engineer—Age 29. B.S. in Mechanical Engineering. Graduate of A.A.F. Post Graduate Engineering School. Two years' experience as aeronautical engineer with large aircraft company. Five and one-half years with Engineering Division, A.T.S.C., Wright Field, in charge of development plastics for aircraft structures. Wide acquaintance with key personnel aircraft, plastics and materials manufacturers, and A.A.F., Bureau of Aeronautics, and other government agencies. Desires responsible position in engineering management or management of development of materials and products.

572. Executive Assistant—Nine years' aviation background consisting of complete course in air-line operations, employment with major air line as meteorologist and trainee dispatcher, and command and important staff assignments in A.A.F. Additional training in basic engineering subjects, manufacturing and business administration; nonaviation experience in office management, selling, manufacturing and organizational consulting. Desires connection as assistant to air-line executive in operations or administration but will consider other positions where versatility and broad knowledge, plus dependability and mature thinking are required.

570. Maintenance Engineer—B.M.E., 1939. Five years' varied experience on transoceanic aircraft with air line. Accumulated 2,700 hours as flight engineer. Speaks Portuguese and German. Holds valid A & E and Private Pilot's license. One and one-half years with Army Air Transport Command. Interested in position with air line or with manufacturer designing transport aircraft.

569. Washington Representative—Reserve Officer and senior pilot desires to handle aviation concerns' Washington business. Fourteen years' industrial experience in aeronautical design, manufacture, testing, and operation of aircraft, engines, and accessories, plus 6 years' military duty in very responsible executive, engineering, and maintenance billets. Reliable, resourceful, and well established in Washington.

566. Graduate Engineer—Eight years' experience in materials and process, stress analysis, and structural testing. Desires position in similar or production field with aircraft, accessory manufacturer, or air line. Locality immaterial.

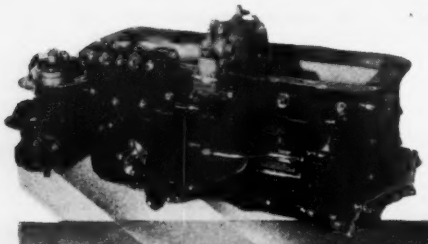
565. Engineer and Executive—Almost 30 years' experience on airplane and accessory design, airport selection and layout, and airplane operations engineering. Good organizer and manager, sound business experience, capable technical writer, wide knowledge of materials and processes.

564. Aeronautical Engineer and Flight Test Pilot—B.S. and M.S in Aeronautical Engineering from M.I.T. Two thousand hours' flight time obtained as Air Corps pilot in all types of airplanes including 2 years with Air Transport Command as first pilot in Alaskan Division. Holds commercial pilot certificate single and multi-engined land ratings. Recent experience as aerodynamicist in rotary wings.

563. Aeronautical, Mechanical, and Electrical Engineer—Electrical Engineering degree; 37 years old Thirteen years' experience Automotive parts supplier's experimental shops (holds journeyman's rating as machinist); aircraft landing gear design and testing for accessory manufacturer; aircraft hydraulic design and administrative engineering for aircraft manufacturer; sales engineer for aircraft landing gear; industrial hydraulic design; aircraft seat design and testing. Complete résumé on request. Desires position as Sales Engineer Administrative Engineer, Design Engineer, Technical Consultant, or other in aircraft or other lines in Los Angeles area with aggressive organization.

561. Teacher—M.S. Ae.E., 5 years' teaching senior and graduate courses in airplane structures and design, 9 years' industrial experience in design and stress analysis. Has done considerable amount of research for industrial companies and Government agencies.

560. Industrial and Aeronautical Engineer—B.S. in Industrial Engineering, major in Aeronautical Engineering from Iowa State College, 1943. Age 25. One year's experience with large West Coast aircraft concern. Served as an Aeronautical Engineering Specialist for over a year in the Navy Air Corps. At present, Production Officer at a Naval Air Station in charge of all repair shops and supervision of 400 men. Work includes checks, maintenance, repairs, and overhauls of latest-type Navy aircraft. Desires responsible position in the production department of an aircraft firm. Would also accept stress analysis or aerodynamicist position.



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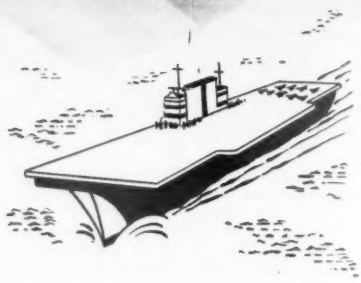

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559. Engineer-Journalist—Three years' study in aeronautical engineering at Rensselaer Polytechnic Institute. Two and one-half years' service with the U.S. Marines. Two years' engineering under the ESMWT night schools; 3 years' experience in the engineering department of a large eastern aircraft concern as an engineer and draftsman; and 12 years' practical experience in photography, plus journalism experience in the service and in civilian life. Desires permanent position with a good technical publication or in the advertising, merchandising, or public relations department of a large eastern aircraft concern, preferably in vicinity of New York.

558. Aeronautical Engineer—B. of Aero.E., New York University, 1944. Two years of liaison engineering experience in U.S. Navy, plus previous limited association with large manufacturer as Aerodynamicist and Flight Test Engineer. Desires position with small organization in New York area, not necessarily aircraft, to do design and development work.

557. Aeronautical Engineer—B. of Aero.E., New York University and 2 years of law study. Four years' experience in static test and structural flight test experimental work on Naval aircraft. Experience in all phases of experimental work involving instrumentation and tests of aircraft structures. Plans to complete LL.B. degree in 1 year of evening school. One year part-time experience with patent attorney. Desires position in New York Metropolitan or Los Angeles area as patent engineer or aeronautical engineer. Opportunity desired for working into engineering-law position.

556. Production and Service Engineer—Nine years' practical experience in aircraft planning, scheduling, manufacturing processes, and service engineering with large eastern aircraft manufacturer. Experience includes planning and scheduling of production aircraft and spare parts, improvement and simplification of manufacturing processes, especially machining processes, and the compilation and editing of erection and maintenance manuals for production and experimental aircraft. Veteran of World War II. Desires position of administrative capacity in production management or service engineering.

553. Aeronautical Engineer—Canadian, age 28, married. Four years' responsible work in aircraft manufacturing and air-line engineering; previous writing and administrative experience. Broad educational background, including American. Thoroughly familiar with both American and British airworthiness requirements. Interested in development engineering. Continental or foreign location acceptable. West Coast preferred.

551. Aeronautical Engineer—General design experience on wood and metal aircraft, Army, Navy, and C.A.A. Considerable electrical and radio experience. Present standing Electrical and Radio Group Leader. Desires salaried position in vicinity of New York City.

549. Physicist—M.I.T. graduate. Five years' general aerodynamic experience. Two years on supersonic airflow, including the design and development of a supersonic wind tunnel. Three years on engine cooling and airplane performance. Six years' general manufacturing experience. Wants responsible position, preferably in a missile development program.

547. Aeronautical Engineer—Assistant Professor of Aeronautical Engineering at large state university desires change. Has M.S. in Aeronautical Engineering; 8 years of teaching; industrial, consulting, and research experience in many phases of aeronautical engineering. Private pilot. Prefers university position with research and consulting possibilities. Will consider responsible industrial position.

546. Field or Sales Engineer—Seven years' experience in foreign and domestic field in installation and sales engineering for major engine company. Desires field or sales engineering position with engine or air-frame company. Well established contacts on West Coast and Buffalo area. References and background available upon request.

545. Aeronautical Engineer—Six years' experience in engineering as Assistant Chief of Structures, Project Engineer, and on Army aircraft maintenance. Desires responsible engineering position with company developing roadable-type aircraft.

544. Aeronautical Engineer—B.A. in Ae.E. Recently discharged from U.S. Army. One year's experience in design of wooden gliders and metal cargo planes. Six months' experience in research analysis in jet propulsion. Also experienced in helicopter design. Excellent references.

543. Experimental Test Pilot—Five years of experimental and production flight-testing of fighter, dive bomber, and attack-type aircraft. All experience has been with contractors. Approved by Army and Navy for demonstration test work. Commercial license, single- and multi-engined ratings, instrument rating, instructor's rating. Recent experience in jet-propelled and other high-performance experimental aircraft. Interested in flying or nonflying position offering future.

542. Sales and Service Engineer—Ten years of varied experience in the aircraft industry, both in fixed and rotary wing. Four and one-half years' experience in Sales Engineering, remaining experience in aircraft design. Desires connection with personal aircraft manufacturer or sales agency in the New York area. Holds valid private pilot certificate.

541. Translations—Aeronautical engineer and physicist would translate German technical papers and books into English. Thoroughly familiar with terminology in both languages.

540. Executive Accountant—Desires to join a progressive company as Treasurer, Controller or financial officer, or their chief assistant. Eight years' experience as Treasurer, Secretary. Also in plant management with one of the largest light-plane manufacturers. Has splendid banking connections. Desires to return to the aviation field. Willing to go to any part of the country, but prefers East or Middle West. Salary open, depending on future possibilities. Available within 30 days.

539. Technical Writer—Editor—Writing problems expertly handled by former editor of aircraft manuals. Low cost, confidential service on any written work from minor corrections to rewriting and ghostwriting. Reports, articles, speeches, and monographs guaranteed to be put into clear, forceful, letter-perfect English.

533. Production Executive—Aeronautical Engineering degree, M.I.T. graduate. Industrial management experience. Eight and one-half years in the aeronautical field, including engineering design and layout, research and process, manufacturing and matériel, engineering officer U.S. Navy. Seeks executive or administrative post in field service and maintenance, factory and production management, matériel, or as line assistant to top executive. Available one month's notice.

532. Aeronautical Engineer—Bachelor of Aeronautical Engineering Degree from New York University with honors. Age 25. Two years' experience in design and research of aircraft propellers involving original administrative work on all phases of propeller design, theory, flight, testing, and production. Most original designs used by the services during the war. Flying experience. Two years' administrative experience as an officer in the U.S. Navy. Familiar with all phases of aviation. Desires responsible position in development, research, or administration in aeronautical organization with future. Has the initiative and ability to get things done. New York area preferred but not necessary. Excellent references.

531. Management Executive—Mechanical Engineer (1924), now Production Manager of medium-sized organization. Twenty-two years' practical experience in aircraft production, 12 years as executive in production control, manufacturing and plant management. Familiar with latest metal and wooden aircraft manufacturing techniques. Able leader, efficient organizer, experienced in labor relations. Expert in setting up and operating production programs of new aircraft. Writes and speaks fluently English, French, and German. Desires permanent position with well-established organization where knowledge, experience, initiative and results are of prime importance.

530. Design Engineer—Seven and one-half years' well-rounded aircraft design experience, including 4 years' rotary wing. Engineering administrative experience. Three years' experience power plant; group leader, controls; group leader, preliminary design; design engineer, general. Location open.

525. Aeronautical Engineer—Age 32. Professor of Aeronautical Engineering with 5 years' administrative experience as head of department in large engineering college. Industrial experience. Experience in all phases of theoretical and applied aerodynamics, performance, stability, and preliminary design. Will consider responsible position with accredited college or university, research organization, or industrial concern.

524. Electrical and Aeronautical Engineer—Has done graduate work in electrical and aeronautical engineering. Four years' experience as Chief Inspection Supervisor of a leading aircraft factory. Certified Ground Engineer. Desires contact with interested aircraft manufacturers or air lines for business enterprise in the East.

523. Aeronautical Engineer—B.A.E., New York University. One year aeronautical research experience. Four years' stress analysis, liaison, design, production expediting with two large aircraft manufacturers. Familiar with aircraft fabrication practice. Desires responsible production management position.

522. Mechanical Engineer—Native Polish; Master of Science degree in Engineering. Would like to translate Polish and Russian scientific and technical papers.

521. Manager—M.I.T., 1922, Engineering, Administration, Mechanical and Electrical Engineering Option. Twenty-three years' experience in industry as Industrial Engineer, Plant Engineer, Production Manager, General Manager. Last 5 years with prominent U.S. corporation as General Manager in Divisions manufacturing aircraft generators, motors, controls, and marine navigational instruments and mechanisms. A complete résumé will be sent upon request.

519. Field Representative—Quick to analyze and detect trouble. Engineer-mechanic training. Formerly technical representative for Wright and Ranger. Constellation experience gained at Lockheed Service, Burbank. Many years with Pan American Latin American Division. C.A.A. certificates. Extensive knowledge aviation fuels and oils. Free to travel. Available to progressive company.

517. Aeronautical Engineer—Five years' experience with a leading aircraft manufacturer. Extensive experience in specification writing, weight and balance control, layout and design. Inventive ability and production minded. Experienced in supervising a large group. Desires a permanent and responsible design position in progressive organization in New York area where his experience and abilities can be fully utilized.

515. Aeronautical Engineer—1938. Two years as detailer on hydraulic, mechanical, and electrical equipment for aircraft. Four years as development engineer in the research department of a large aircraft company; was partially responsible for complete engineering (basic design, performance prediction, prototype construction, and flight test) of a small airplane. Now directing the activities of a group of mechanical, chemical, and industrial engineers as Supervisor of Production Engineering and Tooling for a non-aircraft company. Desires to re-enter the aeronautical field in a responsible position in development work for an aircraft company. Would be particularly interested in assuming responsibility for the complete development of a new private airplane project.

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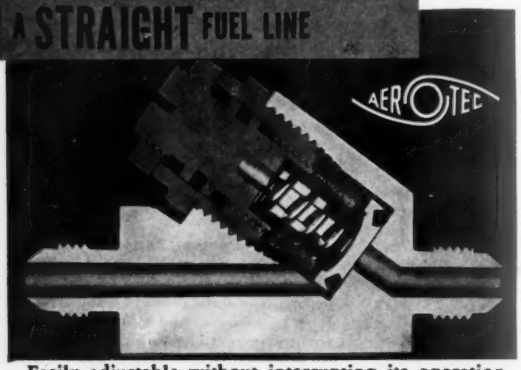

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A sectioned view, actual size, is illustrated above, showing access to the adjusting screw. Write for detailed description.

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514. Aeronautical Engineer and Pilot—B.S. in Mechanical Engineering, M.S. in Aeronautical Engineering, both from M.I.T. Six months' experience as aerodynamicist with large aircraft company in design and performance analysis of large transport and military aircraft. Familiar with C.A.A. performance and operating requirements of transport aircraft. 1,700 hours flying experience in all types of aircraft includes 1,300 hours of twin- and four-engined time. Two and one-half years in Air Transport Command as pilot in air-line operations with some administrative experience as operations officer. Commercial pilot, single- and multiengined land, flight instructors' ratings. Six months' administrative experience with small nonaeronautical manufacturing concern. Prefers position involving flying.

513. Aeronautical Engineer—B.S. in Ae.E., Purdue University; M.S. in Ae.E., New York University; studying for Sc.D. at M.I.T. Age 25, single. Desires position as aerodynamicist.

510. Mechanical Aeronautical Engineer—B.S.M.E. (Aero Option); 29 years old; 6 years' experience on propellers and propeller accessories and manufacture of precision parts. Two years as design engineer on helicopter rotors and controls. Some experience in textile machinery and power chucks. Desires responsible position as design or project engineer in Eastern area.

508. Aeronautical Engineer—B.S. in Ae.E. Three years' experience as assistant project engineer with prominent light plane company. One year as research engineer. Experienced in structural design, static testing, aerodynamics, and flight-test work. Familiar with C.A.A. requirements. Married; 28 years old; private pilot.

507. German Translations—Accurate translations of German technical literature in aeronautics and related sciences.

506. Aeronautical Administrative Engineer—Englishman with 18 years' aeronautical experience; A.F., Royal Aeronautical Society; Mechanical Sciences Degree (B.A. Cambridge University). Spent from July, 1938, to December, 1945, on British Government service in U.S.A. At present with Aeronautical Inspection Directorate in England. Speaks some French and a little Polish. Desires position with commercial air line anywhere, but preferably in Europe.

504. Aeronautical Engineer—B.S. Ae.E. from the University of Texas. Member of Tau Beta Pi and Pi Tau Sigma. Some postgraduate work. At present is Ensign (A) L, U.S.N.R., with duties as administration officer at a naval air station. Prefers work in design or aerodynamics.

503. Aeronautical Engineer—B.S. in Ae.E., B.S. in E.M. Five years' experience in design, layout, and stress analysis of large and small military and commercial airplanes with major aircraft companies. Now holds Structural Engineer rating. Experience in supervision of stress analysts, liaison engineers, and salvage engineers. Well grounded in preliminary design. Desires responsible position in aircraft or other concerns utilizing light metal stressed construction in Mexico or other Latin-American country. Available immediately. Details upon request.

501. Aeronautical Engineer—Young, Chinese; 4 years' engineering experience; excellent connections. Desires a permanent and responsible engineering, sales, or technical position with aviation company or allied industry in China or in the Far Eastern territory.

500. Pilot—Engineer—B.S. in Ae.E., 1943. World War II veteran. Two years in Army Air Corps on heavy and very heavy bomber-type aircraft. Holds valid commercial pilot certificate. Prefers position involving engineering and flying but will consider engineering alone. Will locate anywhere.

499. Aeronautical Engineer-Aerodynamicist—B.S. Ae.E. Ten months' research experience testing wings, tail surfaces, propellers in wind tunnel. Six months' aircraft-engine research and development. Available immediately. New York area preferred.

496. Aeronautical Engineer—World War II veteran; B.S. in GE with AE option from Georgia Tech. Twenty-four years old; 2 years', 8 months' experience in the development of aircraft engines (conventional and jet) and propellers in the Engineering Division, Air Technical Service Command, Wright Field. Will locate anywhere. No objection to traveling.

495. Manufacturing Executive—Twenty years' experience in engineering and production, both United States and England. Desires connection with small concern where experience and ability can prove results. East Coast preferred. Available one month's notice.

494. Airline Engineer—For embryo air lines in need of financial analyses and operational and management studies. Has two aeronautical engineering degrees (working for third). Six years' aeronautical experience—air line, manufacturing, teaching.

493. Power-Plant Designer—Age 26, Mechanical and Aeronautical degrees. Five years' experience with power-plant installation problems including cowling and cooling, duct design, and exhaust systems. Recent experience in turbojet engine installation work, including induction systems, tail pipe, and nozzle. Excellent references.

488. Engineer—Design or Administrative—Twenty years' practical experience in aircraft design and administration with well-established firms. Design experience includes preliminary, proposal, and manufacturing phases of both fixed and rotary wing aircraft. Desires position of responsibility in either design or administration. East Coast preferred.

487. Engineer—Aeronautical, Sales and Personnel—Ex A.A.F. Major, recently released by Air Technical Service Command. Age 32; married. Military experience: 3 years as Engineering Officer at one of largest bomber plants, assisting contractor in handling engineering with prime designer and A.A.F.; approximately 1 year as service liaison engineer. Civilian experience: 1 year as Director of Personnel and Labor Relations for a leading aircraft accessory manufacturer; 3 years as sales engineer, and creator and organizer of that department for same company; 3½ years' diversified experience in retail sales, aircraft and allied industry production and engineering. Desires connection wherever experience can be best utilized. Excellent references.

486. Aeronautical Engineer—Graduate with 12 years' practical experience in aircraft-engine design. Familiar with engineering, development and testing of superchargers. Two years' experience as Chief Engineer in plastics plant for aircraft turrets and noses. Desires engineering position preferably supervisory. New York area preferred.

485. Pilot—Marine Air Corps; age 24. Commercial license with single, twin, land ratings. Partial college education in business administration. Previous practical business experience; small-scale sales experience. Desires position with aviation firm or aviation products firm in sales-contact, field representative work. Future opportunity primary consideration; salary secondary.

484. Aeronautical Engineer—B.S. Ae. Navigation and drafting experience in U.S. Army Air Forces. Desires position as draftsman or aerodynamicist with air line or manufacturer. Location open.

483. Aerodynamicist—B.Aero.E. with distinction from the University of Minnesota; age 26, married. Four full years' experience with prime Navy contractor in stability and control, compressibility, wind-tunnel test, performance, and aerodynamic design of all types of aircraft. Desires position with aircraft, business, or educational organization. Opportunities to apply knowledge and to advance are of primary interest; salary secondary. Any location considered. Available immediately.

482. Research Professorship—or equivalent nonindustrial research connection is desired by aircraft engineering executive, who wants to change from industrial work to fundamental research in applied physics and theoretical aerodynamics. Sc.M. in Aeronautical Engineering from Massachusetts Institute of Technology. Twenty years' experience as head of aircraft engineering department.

480. Physiological Psychologist—Ph.D. 1939. Ten years' research experience in the field of human engineering in aviation, including vision, visibility, cockpit illumination, exterior lighting of aircraft, instrument lighting, hearing, speech intelligibility, anoxia fatigue, drugs, selection, crash analysis, in-flight and preflight feeding, and passenger comfort. Formerly college instructor; at present, Officer-in-Charge, Navy Lighting Projects. Desires position with an air line to develop a program of "Test and Evaluation," preferably in Department of Engineering Research and Development. Will advise engineering staff on human engineering and will test and evaluate equipment, present and proposed, with respect to efficiency of pilot and crew and to passenger comfort.

478. Aeronautical Engineer—Former Army pilot (all types) and engineering officer. Many years' experience in design, inspection, manufacture and test. Hydraulics and supercharger specialist. Broad knowledge of aerodynamics, thermodynamics, and design practice. Excellent engineering draftsman; holder of patents; many ideas for future development. Desires development work on engines or airplanes.

473. Administrative Engineer—B.A.E. Seven years' experience in airplane design (preliminary and production), research, shop work, factory liaison, and salvage work. Group Leader. Airplane and helicopter experience. Available as assistant to busy executive in general management or engineering; aircraft or allied field. New York area preferred but not essential.

471. Aeronautical Engineer—B.S. in Ae.E., 14 years' flying and 12 years' engineering experience including design problems, development of test and control devices, performance studies and conduct of airplane, power plant and accessory flight-test projects, seeks product-improvement position requiring design aptitude and test ability Interests not restricted to aircraft field provided employer can benefit from aviation background.

470. Aircraft Power Plant Engineer—B.S. in M.E.; 12 years' in aviation with leading aircraft and engine manufacturer. During recent years in charge projects, including personnel, involving installation, operation, maintenance, and overhaul of aircraft powerplant equipment. Qualified to assume complete management of such projects. Wide acquaintance with key personnel airlines, aircraft manufacturers, distributors, service bases, A.A.F., and Navy Bureau of Aeronautics. Travel or live anywhere.

468. Expert Mechanical Design Engineer—Fifteen years' internal combustion engine design experience, including 3 years on diesel engines, 6 years on aircraft engines, last 2 years on high-temperature rotating machinery including gas-turbine aircraft auxiliary power plant. Interested in design supervision, engineering liaison, or sales engineering.

353. Industrial Engineer—B.S.M.E. Eleven years' experience in selecting equipment and supervising installations for aircraft manufacturing processes, including experience in production of airplane motors; also 25 years' experience in the automotive engineering and production field. In a position to do consulting work as industrial engineer.

292. Manufacturing Executive—Mechanical Engineer with 26 years' experience in production management covering planning, procurement, tooling, procedures, precision machine-shop practice, production control, and inspection. Aircraft manufacture or kindred field.

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514. Aeronautical Engineer and Pilot—B.S. in Mechanical Engineering, M.S. in Aeronautical Engineering, both from M.I.T. Six months' experience as aerodynamicist with large aircraft company in design and performance analysis of large transport and military aircraft. Familiar with C.A.A. performance and operating requirements of transport aircraft. 1,700 hours flying experience in all types of aircraft includes 1,300 hours of twin- and four-engined time. Two and one-half years in Air Transport Command as pilot in air-line operations with some administrative experience as operations officer. Commercial pilot, single- and multiengined land, flight instructors' ratings. Six months' administrative experience with small nonaeronautical manufacturing concern. Prefers position involving flying.

513. Aeronautical Engineer—B.S. in Ae.E., Purdue University; M.S. in Ae.E., New York University; studying for Sc.D. at M.I.T. Age 25, single. Desires position as aerodynamicist.

510. Mechanical Aeronautical Engineer—B.S.M.E. (Aero Option); 29 years old; 6 years' experience on propellers and propeller accessories and manufacture of precision parts. Two years as design engineer on helicopter rotors and controls. Some experience in textile machinery and power chucks. Desires responsible position as design or project engineer in Eastern area.

508. Aeronautical Engineer—B.S. in Ae.E. Three years' experience as assistant project engineer with prominent light plane company. One year as research engineer. Experienced in structural design, static testing, aerodynamics, and flight-test work. Familiar with C.A.A. requirements. Married; 28 years old; private pilot.

507. German Translations—Accurate translations of German technical literature in aeronautics and related sciences.

506. Aeronautical Administrative Engineer—Englishman with 18 years' aeronautical experience; A.F., Royal Aeronautical Society; Mechanical Sciences Degree (B.A. Cambridge University). Spent from July, 1938, to December, 1945, on British Government service in U.S.A. At present with Aeronautical Inspection Directorate in England. Speaks some French and a little Polish. Desires position with commercial air line anywhere, but preferably in Europe.

504. Aeronautical Engineer—B.S. Ae.E. from the University of Texas. Member of Tau Beta Pi and Pi Tau Sigma. Some postgraduate work. At present is Ensign (A) L, U.S.N.R., with duties as administration officer at a naval air station. Prefers work in design or aerodynamics.

503. Aeronautical Engineer—B.S. in Ae.E., B.S. in E.M. Five years' experience in design, layout, and stress analysis of large and small military and commercial airplanes with major aircraft companies. Now holds Structural Engineer rating. Experience in supervision of stress analysts, liaison engineers, and salvage engineers. Well grounded in preliminary design. Desires responsible position in aircraft or other concerns utilizing light metal stressed construction in Mexico or other Latin-American country. Available immediately. Details upon request.

501. Aeronautical Engineer—Young, Chinese; 4 years' engineering experience; excellent connections. Desires a permanent and responsible engineering, sales, or technical position with aviation company or allied industry in China or in the Far Eastern territory.

500. Pilot—Engineer—B.S. in Ae.E., 1943. World War II veteran. Two years in Army Air Corps on heavy and very heavy bomber-type aircraft. Holds valid commercial pilot certificate. Prefers position involving engineering and flying but will consider engineering alone. Will locate anywhere.

499. Aeronautical Engineer-Aerodynamicist—B.S. Ae.E. Ten months' research experience testing wings, tail surfaces, propellers in wind tunnel. Six months' aircraft-engine research and development. Available immediately. New York area preferred.

496. Aeronautical Engineer—World War II veteran; B.S. in GE with AE option from Georgia Tech. Twenty-four years old; 2 years', 8 months' experience in the development of aircraft engines (conventional and jet) and propellers in the Engineering Division, Air Technical Service Command, Wright Field. Will locate anywhere. No objection to traveling.

495. Manufacturing Executive—Twenty years' experience in engineering and production, both United States and England. Desires connection with small concern where experience and ability can prove results. East Coast preferred. Available one month's notice.

494. Airline Engineer—For embryo air lines in need of financial analyses and operational and management studies. Has two aeronautical engineering degrees (working for third). Six years' aeronautical experience—air line, manufacturing, teaching.

493. Power-Plant Designer—Age 26, Mechanical and Aeronautical degrees. Five years' experience with power-plant installation problems including cowling and cooling, duct design, and exhaust systems. Recent experience in turbojet engine installation work, including induction systems, tail pipe, and nozzle. Excellent references.

488. Engineer—Design or Administrative—Twenty years' practical experience in aircraft design and administration with well-established firms. Design experience includes preliminary, proposal, and manufacturing phases of both fixed and rotary wing aircraft. Desires position of responsibility in either design or administration. East Coast preferred.

487. Engineer—Aeronautical, Sales and Personnel—Ex A.A.F. Major, recently released by Air Technical Service Command. Age 32; married. Military experience: 3 years as Engineering Officer at one of largest bomber plants, assisting contractor in handling engineering with prime designer and A.A.F.; approximately 1 year as service liaison engineer. Civilian experience: 1 year as Director of Personnel and Labor Relations for a leading aircraft accessory manufacturer; 3 years as sales engineer, and creator and organizer of that department for same company; 3½ years' diversified experience in retail sales, aircraft and allied industry production and engineering. Desires connection wherever experience can be best utilized. Excellent references.

486. Aeronautical Engineer—Graduate with 12 years' practical experience in aircraft-engine design. Familiar with engineering, development and testing of superchargers. Two years' experience as Chief Engineer in plastics plant for aircraft turrets and noses. Desires engineering position preferably supervisory. New York area preferred.

485. Pilot—Marine Air Corps; age 24. Commercial license with single, twin, land ratings. Partial college education in business administration. Previous practical business experience; small-scale sales experience. Desires position with aviation firm or aviation products firm in sales-contact, field representative work. Future opportunity primary consideration; salary secondary.

484. Aeronautical Engineer—B.S. Ae. Navigation and drafting experience in U.S. Army Air Forces. Desires position as draftsman or aerodynamicist with air line or manufacturer. Location open.

483. Aerodynamicist—B.Aero.E. with distinction from the University of Minnesota; age 26, married. Four full years' experience with prime Navy contractor in stability and control, compressibility, wind-tunnel test, performance, and aerodynamic design of all types of aircraft. Desires position with aircraft, business, or educational organization. Opportunities to apply knowledge and to advance are of primary interest; salary secondary. Any location considered. Available immediately.

482. Research Professorship—or equivalent nonindustrial research connection is desired by aircraft engineering executive, who wants to change from industrial work to fundamental research in applied physics and theoretical aerodynamics. Sc.M. in Aeronautical Engineering from Massachusetts Institute of Technology. Twenty years' experience as head of aircraft engineering department.

480. Physiological Psychologist—Ph.D. 1939. Ten years' research experience in the field of human engineering in aviation, including vision, visibility, cockpit illumination, exterior lighting of aircraft, instrument lighting, hearing, speech intelligibility, anoxia fatigue, drugs, selection, crash analysis, in-flight and preflight feeding, and passenger comfort. Formerly college instructor; at present, Officer-in-Charge, Navy Lighting Projects. Desires position with an air line to develop a program of "Test and Evaluation," preferably in Department of Engineering Research and Development. Will advise engineering staff on human engineering and will test and evaluate equipment, present and proposed, with respect to efficiency of pilot and crew and to passenger comfort.

478. Aeronautical Engineer—Former Army pilot (all types) and engineering officer. Many years' experience in design, inspection, manufacture and test. Hydraulics and supercharger specialist. Broad knowledge of aerodynamics, thermodynamics, and design practice. Excellent engineering draftsman; holder of patents; many ideas for future development. Desires development work on engines or airplanes.

473. Administrative Engineer—B.A.E. Seven years' experience in airplane design (preliminary and production), research, shop work, factory liaison, and salvage work. Group Leader. Airplane and helicopter experience. Available as assistant to busy executive in general management or engineering; aircraft or allied field. New York area preferred but not essential.

471. Aeronautical Engineer—B.S. in Ae.E., 14 years' flying and 12 years' engineering experience including design problems, development of test and control devices, performance studies and conduct of airplane, power plant and accessory flight-test projects, seeks product-improvement position requiring design aptitude and test ability Interests not restricted to aircraft field provided employer can benefit from aviation background.

470. Aircraft Power Plant Engineer—B.S. in M.E.; 12 years' in aviation with leading aircraft and engine manufacturer. During recent years in charge projects, including personnel, involving installation, operation, maintenance, and overhaul of aircraft powerplant equipment. Qualified to assume complete management of such projects. Wide acquaintance with key personnel airlines, aircraft manufacturers, distributors, service bases, A.A.F., and Navy Bureau of Aeronautics. Travel or live anywhere.

468. Expert-Mechanical Design Engineer—Fifteen years' internal combustion engine design experience, including 3 years on diesel engines, 6 years on aircraft engines, last 2 years on high-temperature rotating machinery including gas-turbine aircraft auxiliary power plant. Interested in design supervision, engineering liaison, or sales engineering.

353. Industrial Engineer—B.S.M.E. Eleven years' experience in selecting equipment and supervising installations for aircraft manufacturing processes, including experience in production of airplane motors; also 25 years' experience in the automotive engineering and production field. In a position to do consulting work as industrial engineer.

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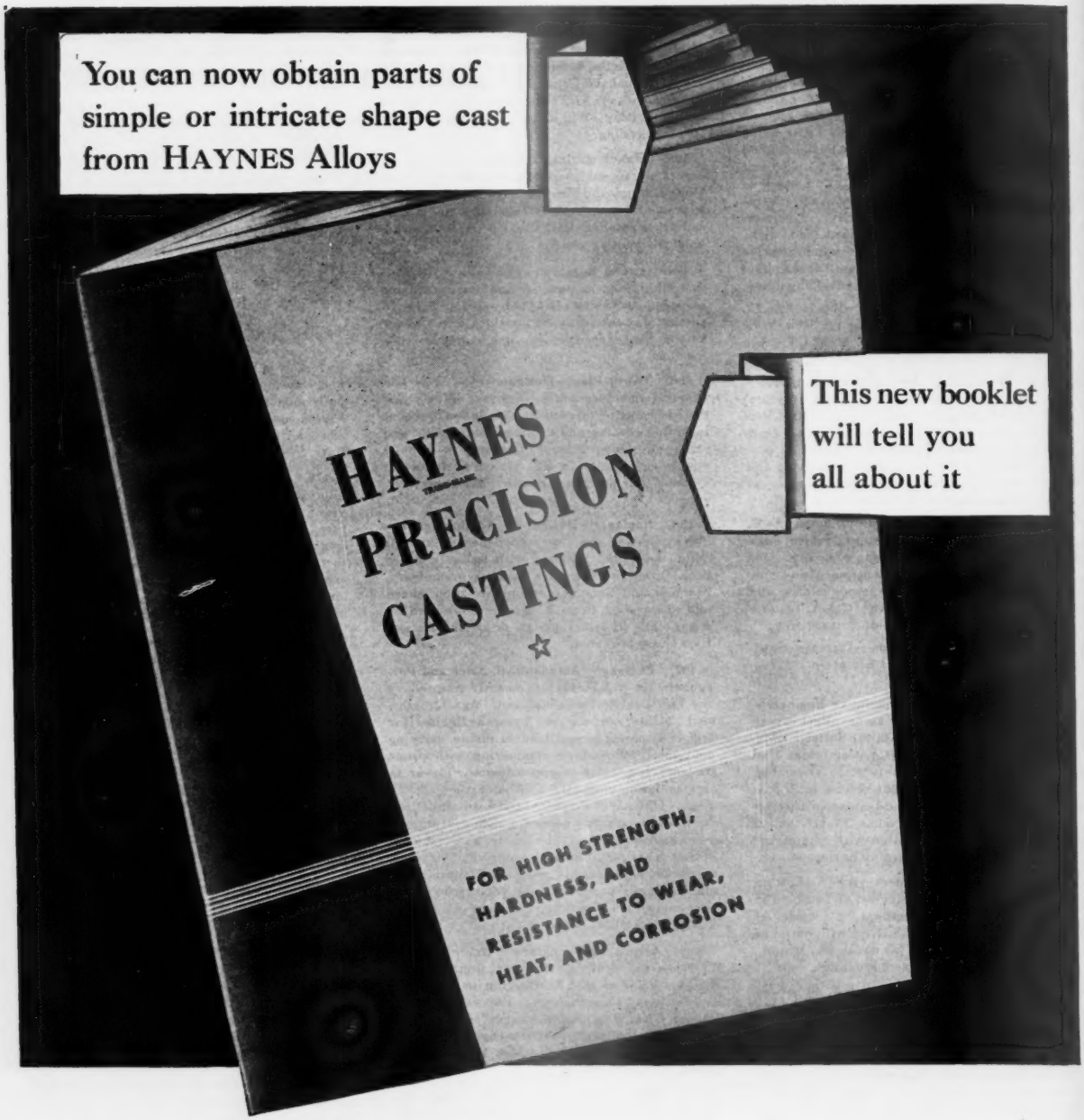
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